Special Relativity Effects Are Optical Illusions

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PREFACE

About five or six years ago a guy who went to the same church that I was attending then wanted to get together with me from time to time to talk about science and philosophy. He was a character. He loved science, but as I soon discovered, he loved *Star Trek* even more. He was in his late fifties at the time, and I think he used to watch the original series as a kid when it aired on TV, or at least the reruns. He calmly explained to me one day that he could tolerate heat a lot better than most people because he was half Vulcan and it is a lot hotter there than it is on earth. He was completely serious. In some sense he seemed to know that the show was not real, but at the same time he kind of thought that maybe it actually was. Perhaps it was like when my older brother, being the killjoy that he was, told me that professional wrestling was fake back when I was eight years old. At some level I knew that he was right, but there was still a little part of me that wondered if maybe he was just stupid and it actually was true after all. Boy I would have loved that. Anyway, that is how this guy was with *Star Trek*. He knew that it was a TV show, but he also thought that it accurately represented what it was going to be like in the future, and I think he really did believe that he was part Vulcan. Interestingly, though, when I asked him if he ever went to any of the conventions he said that he had gone before but he didn't like them very much because 'those people are crazy'. This was coming from a guy who had not one, but two *Star Trek* suits in his closet. I thought that was pretty hilarious.

I didn't find these meetings to be very productive. He really liked logic and paradoxes, but I didn't feel like I was getting much out of it. It seemed like we talked about the same stuff time after time, and he would go off on a lot of tangents for a really long time. Even though he was very interested in science and knew quite a few scientific facts, he didn't really seem to have a very deep understanding of it because he could not answer most of my questions. He was also kind of clingy. After an hour and a half or more I would finally just say that I had to go and get up to go out to my car but he would follow me out there and try to hold the car door open to keep me from leaving. He would also leave voicemails on my phone that were kind of funny but also a little bit creepy. He would say things like: 'It is always nice to see someone as esteemed and dignified as you.' In a way it was flattering, but also a little bit weird. He was harmless, of course, but it was just kind of awkward. I started trying to come up with excuses for why we could not meet outside of church. It was somewhat difficult to constantly do this, though, so I found myself meeting with him after church once or twice a month.

He really liked to collect books; I don't think he read very many of them, but he liked to have them. He would buy them at garage sales on Saturday and then bring them in to show me on Sunday. He especially loved science books. I looked through some of them as we were talking and finally one day I asked if I could borrow one and then give it back to him the next week. I don't think he really wanted to, at least at first, but he finally let me borrow a book, or a few of them, each time we met. I would read them and then give them back to him the next time, and borrow more. I read books on such topics as the Big Bang Theory, String Theory, quantum mechanics, non-Euclidian geometry, etc. Because of this my interest in physics began to grow. I have found the concepts in physics interesting for some time but I did not take any classes in it while in college because I was intimidated by the math. Nobody in my family is very good at math, and I am no exception, so I was too intimidated to take a college physics course because of worries about what it might do to my GPA. It is kind of interesting, looking back, to think about how this chance acquaintance with my endearingly quirky little friend led to all this; I am grateful that he helped to stoke my interest in science.

As my interest grew I found a number of books on CD at the library that I could listen to while commuting. I found one on Darwin and the origin of species, another about astronomy, and so forth, but the one that had the biggest impact on me was a biography of Einstein by Walter Isaacson. I have been interested in Einstein since I was a child. Everybody always speaks of him with such great reverence, as perhaps the greatest genius of all time. I knew a little bit about the Theory of Relativity, such as $E = mc^2$, nothing can exceed the speed of light, no absolute or privileged vantage point etc., but at that time I knew more about the man than his theory, even before listening to the biography. Most biographies and stories about him that I had read did not go into the theory very much. That furthered my perception that it must be really hard to understand, especially if you weren't good at math. I always assumed that it had to be right though, since all of the other scientists thought so, and they said that it had been empirically proven numerous times.

This particular biography did not go into great depth about Einstein's theory either, the focus of it was on his life, but it did talk about the theory a little bit. I heard something that I had never come across before. It briefly mentioned that Einstein believed that as a measuring rod was accelerated up to speeds near the speed of light it *contracted* in the direction of motion so that it would be measured to be shorter. But this would be imperceptible to an observer traveling with the rod because the observer would be contracted in the direction of motion as well and would be completely unaware of any of it. The whole thing sounded so bizarre I almost couldn't believe my ears. I thought maybe I had misunderstood what Isaacson was saying.

I actually wondered right then whether Einstein really meant that it only looked like the rod was contracted from a distance because of some sort of optical illusion, since the object was moving near the speed of light. That seemed to make a lot more sense to me. But the biography did not spend much time on it, so even after listening to it a few more times I was still not quite sure whether Einstein thought that the rod actually contracted or whether it would just look that way to observers in a different reference frame. The whole idea seemed weird, and I wanted to learn more about it, but at that time I was working on other projects and I did not want to become distracted so I did not pursue it any further.

A couple of months later I was reading a teacher's edition of a physical science book for eighth grade students that I got from a college that was selling it for a dollar. I had it for several years before that but I was just then getting around to reading it. I liked it because it explained the concepts in a simple way. (Even Wikipedia articles can sometimes get really technical, full of jargon, and heavy on the equations.) On this day I was reading a section on the Doppler effect. In a sudden flash of insight I immediately thought that length contraction must be because of Doppler shift: that is what made the object appear to contract in the direction of motion! The section was actually about Doppler shift as it relates to sound waves, but I was sure that had to be what was going on. That simple thought was the origin for this whole project.

However, before writing anything I had to find out for sure whether Einstein was really saying that the object itself is contracted or whether he thought that it only appeared to be contracted, and I began to study the Theory of Relativity in depth. As it turns out, he did think that the measuring rod really does contract in the direction of motion. I discovered that he also believed some other very strange things. I studied it for about two years in many popular sources before writing anything about it, and I was shocked to discover just how weird - and implausible - the Theory of Relativity actually is. Much to my surprise, I realized after studying it that I didn't believe that it was true at all.

The next question was what to do with that information. On one hand I knew that if I could disprove the theory that would be a really important contribution to science, and that was really exciting. But I was also hesitant. I knew that I was going to get a lot of flak for it, and probably some mocking, especially because I am not even a physicist. (Although I now realize that it might have made it even harder if I was a physicist, which I will discuss in the final section.) If you have ever read online physics forums you know that they are not nice to each other. Some responses are incredibly condescending and rude when addressing what I believe are ernest questions. I can imagine how those people would respond to what I am saying.

For awhile I just sat on it. I was not sure if I really wanted to take this project on. It felt almost like being a whistleblower, and I expected to be attacked the same way that whistleblowers often are. Would it even be worth it if I couldn't convince anybody anyway? Not only am I disagreeing with the person that most people consider the greatest genius of all time - in his subject area of expertise, while it is not my subject area of expertise - I am also disagreeing with pretty much all of today's leading scientists as well. To do that you had better be damn sure you are right. Nobody likes being mocked, and it would be humiliating to be wrong and have that mocking be justified.

Basically I was just intimidated by the project and the criticism that I knew it would receive. Even while working on it I have gone through long periods of procrastination where I have a hard time being motivated to finish and I wonder why I am even bothering to go to all this work when probably no one or hardly anyone will listen. But what finally changed my mind was the realization that probably somebody else out there has had the same idea, or will soon, because it is a fairly straightforward simple idea. I would have been really disappointed in myself if I did have the idea first but didn't write about it simply because of the fear of what people would say. That is cowardly. Sometimes you have to risk looking like a fool in order to do something ground-breaking and important.

Secondly, I felt, and still feel really good about my arguments. I hope that I am not Don Quixote attacking wind mills - I do worry that maybe I still do not have a complete understanding of the General Theory of Relativity because I have relied on popular sources written for a lay audience rather than the actual scientific literature, but I have read from a lot of popular sources and they all seem pretty unified in explaining the general concepts of the theory, so hopefully I have it right. I have found that the Special Theory of Relativity is not actually nearly as hard to understand as it is perceived to be.

Ultimately I decided to proceed, and this is the result. Something that gave me confidence was pondering upon and internalizing the lessons learned from a book by Thomas Kuhn called *The Structure of Scientific Revolutions*. That book helped me to realize that a current scientific paradigm is not necessarily absolute truth, even if it is regarded as such by those within the paradigm. Today's heresy could actually be correct and may eventually lead to a paradigm shift in future generations. It has happened a number of times before.

There was once a time when all the most learned and intelligent men were scholastics; how strange Galileo's arguments must have seemed to them, steeped in the paradigm of Aristotelianism as they were, not because those arguments were wrong but because they questioned what those within the paradigm simply took for granted.

I will be approaching the subject differently than a physicist would. I will be focusing on the philosophical claims that Einstein makes and questioning some of the key assumptions that he and subsequent scientists take for granted. The whole theory is based upon philosophical assumptions, such as the Light Postulate and Scientific Anti-Realism, that I do not believe are true. I will try to give you arguments that are straightforward and relatively free of jargon so that they will be fairly easy to understand for both scientists and non-scientists.

I do hope that you will consider the merits of the arguments themselves rather than focusing on me, the messenger. I have made no claims of being an expert witness or suggested that you ought to simply take my word for it based upon authority; because I have not portrayed myself as a well-accepted authority on physics my credentials should not be on trial. Just think about the arguments themselves. If instead of attacking my arguments you simply attack me personally then you are committing the *ad hominem* fallacy. I am an outsider, it is true, but that does not necessarily mean that I am wrong. Einstein was once an outsider too. At one point he was just a patent clerk who could not get a job in science. If you are willing to hear him out, you should be willing to do the same for me. I will now present my arguments.

LENGTH CONTRACTION

The idea of length contraction 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. For a while 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 15%, at approximately 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 highest possible speed.

Hendrik A. Lorentz agreed and 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 believed 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]

All of this is very similar to the views espoused by Einstein in the Special Theory of Relativity. Most sources omit the history of how these ideas developed over time, which gives the impression that Einstein came up with all of it entirely on his own in one great stroke of genius. That is misleading not only because it misportrays Einstein, but also because it misrepresents the idea, giving it more credibility than it probably deserves by allowing the author to sidestep the issue of why FitzGerald originally came up with it.

One reason that the historical development of the idea is important is that it puts it into context. I think it is somewhat odd that scientists today believe that length contraction happens at all because it was originally proposed as an ad hoc explanation for why the aether was undetectable in the Michelson-Morley experiment. It is rather convenient that all of the measuring devices, even human sense organs are also contracted by just the right amount. Scientists of today, following Einstein, do not believe that there is any such thing as aether, and yet they still believe

[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 many other online sources and science books written for a general audience, 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 themselves did. You can consult those sources directly to find out how they interpret the data and what their arguments are.

that length contraction is a genuine fact about the natural world. It is also strange to me that Einstein did not notice this inconsistency either. He seems to have just believed that length contraction was real and included it as part of his own theory because that was the consensus view at the time. (Einstein even refers to the calculation of it as the 'Lorentz Transformation' after his friend and mentor, who was himself a Nobel Prize winner.)

Modern scientists insist that there is a massive amount of experimental evidence that supports the claim that length contraction really does happen, but I am not sure whether they are referring to evidence for that specific part of the theory or just evidence for Relativity in general. I am not in a position to refute them, so for the sake of argument, I will assume that this is what is observed at speeds approaching the speed of light, although I still have some misgivings about it. I cannot help but wonder if the whole idea is complete bullshit, but I guess it makes sense that the image would probably become distorted somewhat as the object approaches the speed of light.

Anyway, if we do assume that length contraction is observed by viewers in other reference frames the real question is whether the object is actually contracted or whether it only appears that way to some observers. One would expect that when an object is traveling at near the same speed as light it would affect how the image of that object is perceived by a viewer. Where scientists have gone wrong is in assuming that the object itself must be contracted simply because it looks like it has been to some observer a good distance away and moving at a very different speed than that object; why couldn't it just be the image of the object that is distorted rather than the object itself?

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 being contracted in the direction of motion.

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 actually 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 is actually contracted, which explains why its appearance does not change to an observer who is traveling with the rod. If the measuring rod itself really was contracted 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 (in which the observer is not moving with the rod) that the rod would appear to be shorter. This is an important clue that the 'contraction' 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 are also contracted by an equivalent amount, along with all of their measuring instruments (similar to what FitzGerald said). A man that was two meters tall could lie down and he would be shortened to two centimeters 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 before he would go back to being two 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 it 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 and width throughout the whole process. That is part of what is meant by 'relativity': Einstein considers both observations to be equally correct. The question of whether the man was contracted or not does not have a universally true or false answer, it can only be answered relative to a particular reference frame.

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 contraction does not occur within his own frame of reference (it is unclear whether Relativity would say that or whether it would say that it does occur in that reference frame and observers are just unaware of it) it seems to me that he ought to be dead, at least from the perspective of observers in the frames of reference where the contraction 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 dead. 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 have no negative health effects from it?

Another clue that this is not a genuine physical effect is that it does not matter what kind of material the objects are made of, they are all supposedly contracted by the exact same amount. A refrigerator would be contracted proportionally by the same amount as a table or a bed or a person. A measuring stick made out of wood would not break when contracted, even if it went from a meter long to a centimeter, and it would be shortened by the exact same amount as a measuring rod made of metal, no matter what type 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?[2]

Length contraction seems very implausible when it is supposed to be something that happens to the objects themselves, 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 be shortened 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.

According to Relativity 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, which would cause the disk to break apart. Einstein acknowledged this as an 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 (and maybe not even then), and of course then the same problem would arise as to how one could accelerate the form up to speed without it breaking apart.[3] At any rate, it does not really matter whether the proposed solution would actually work or not, the reason

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[2] I guess the answer would have to be space-time. But why does moving really fast create a distortion of space-time and if this is what causes the objects to contract, say by shrinking the space within the atoms between the electrons and the nucleus, then why wouldn't that damage the objects, breaking the stick and killing biological organisms? I will talk about space-time more in part II on the General Theory of Relativity.

[3] As for my own prediction about what would happen with the rotating disk, I do not think that it would be contracted or even appear to be contracted 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 would be created, which is the real reason that the disk would probably break apart.

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.

There are many examples of how our visual perceptions can be distorted. According to one, two, or three point perspective (the last is a pretty accurate representation of how we see things in real life) two parallel lines appear to converge way off in the distance at a vanishing point, but of course we know that they could not actually do that if they are really parallel. One may have noticed this phenomenon with train tracks or a road. It looks like it gets narrower way off in the distance, but once you reach that spot you realize that the lines are approximately just as far apart in those places as they were in the place where you made the initial observation. What is really happening is that everything just looks smaller as it gets further away from you, including the space between the lines. Sometimes things are not actually as they appear, especially when observed from great distances.

Another example 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 below the surface. 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 that my observation when the pole was in the water was just as good as any other observation at any other time (I know that the person who was cleaning the pool perceived the same thing because we talked about it) 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 as well as sound 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 officers 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. In other words, the 'Lorentz Transformation' is a measurement of Doppler shift.

TIME DILATION

Einstein, likely influenced by Henri Poincaré, who discussed it in 1902 (see footnote 13 on page 35), 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 that 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.)[4] This Relativistic slowing of time is sometimes referred to as 'time dilation'. I believe that this is also because of Doppler shift. However, before we get to arguments which support that claim I want to discuss some of the logical problems that come from considering time dilation to be an actual physical effect. This brings us to the Twin Paradox.

TWIN PARADOX

The Twin Paradox is usually presented in the following way: Suppose that one of a pair of identical twins leaves earth on a spaceship and makes a long journey at near the speed of light and then returns; according to the Theory of Relativity he or she will have aged less than the twin who remained behind on earth because time itself slows down for a reference frame that is traveling at near the speed of light. But here is the paradoxical part: According to Relativity there

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[4] 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 last is most likely.

is no absolute motion and no absolute state of rest, one can only say that something is moving or at rest relative to something else. There are two equally correct ways of describing the same relative motion (purportedly) so the twin on the spaceship could just as easily regard himself or herself as being at rest and the earth as moving at near the speed of light instead. If this is true then which twin will have had time dilation occur in his or her reference frame and therefore aged less?

The standard response is to say that the twin that travels in the spaceship accelerates more than the twin on earth, so this is the twin that experiences time dilation while the other does not.

There are at least four problems with this response. The most obvious one is that it is not at all clear that the twin on the spaceship actually does accelerate more than the twin on earth. The earth is not an inertial or stationary reference frame. If we take into account the earth's orbit around the sun, in which it constantly changes direction and speed, the earth's spin, and even the fact that the twin on earth will likely travel around in cars, planes, and even walking, it is quite possible that this twin experiences more acceleration. Any change in speed or direction counts as an acceleration. The spaceship would accelerate a lot at the beginning of the trip and at the end, but once it was up to speed it may continue at a steady velocity for a long time, which means that for much of the trip it would be moving inertially.

Secondly, if time dilation is related to acceleration then why would it keep happening once the reference frame was moving inertially? Is it traveling at a speed that is close to the speed of light that causes time dilation, or is it acceleration? If the former, then what does acceleration have to do with anything?

Third, Einstein himself considered acceleration to be relative. This is from chapter 18 of *Relativity The Special and General Theory*:

> If the motion of the carriage is now changed into a non-uniform motion, as for instance by a powerful application of the brakes, then the occupant of the carriage experiences a correspondingly powerful jerk forwards. The retarded motion is manifested in the mechanical behaviour of bodies relative to the person in the railway carriage . . . *we feel compelled at the present juncture to grant a kind of absolute physical reality to non-uniform motion, in opposition to the general principle of relativity. But in what follows we shall soon see that this conclusion cannot be maintained*. (Italics added for emphasis.)

Einstein later returns to this example and elaborates at the end of chapter 20. Earlier in chapter 20 he argued for the equivalence of acceleration and gravity.

> We can now appreciate why that argument is not convincing, which we brought forward against the general principle of relativity at the end of Section 18. It is certainly true that the observer in the railway carriage experiences a jerk forwards as a result of the application of the brake, and that he recognises in this the non-uniformity of motion (retardation) of the carriage. But he is compelled by nobody to refer this jerk to a "real" acceleration (retardation) of the carriage. He might also interpret his experience thus: "My body of reference (the carriage) remains permanently at rest. With reference to it, however, there exists (during the period of application of the brakes) a gravitational field which is directed forwards and which is variable with respect to time. Under the influence of this field, the embankment together with the earth moves

> non-uniformly in such a manner that their original velocity in the backwards direction is continuously reduced."

It is obvious from this passage that Einstein believed that acceleration (in this case deceleration, which is a form of acceleration) is relative. It is true that the observer would be able to feel the change in speed, but he argues that the observer could just as easily interpret this as his or her own frame being permanently at rest while other reference frames around it are accelerating. So is Einstein just wrong about this? If you think that the Twin Paradox can be resolved by saying that one twin accelerates more than the other you must think so, as that presumes that acceleration is absolute for all reference frames; if it was relative there would be no way to tell which twin accelerated more because observers in each reference frame would interpret the acceleration differently.

This brings us to my fourth point, which is actually the most significant: If there is no such thing as an absolute state of rest, as Einstein insisted, then there would be nothing left but relative motion. The frame has to be accelerating relative to *something*; if there is no absolute state of rest all that would be left is other reference frames and none of them would be preferred over any other. Acceleration would have to be relative, because, according to the theory, relative motion is the only kind of motion that there is.

Now maybe one would argue that acceleration could still be considered invariant without an absolute state of rest or a preferred reference frame because observers in all frames would see that frame accelerate by the same amount no matter how fast their own frame is moving; for instance, if a reference frame speeds up from 100 kph (62.1 mph) to 103 kph an observer that is at rest and another that is moving at 90 kph (55.9 mph) will both measure the acceleration of that frame to be 3 kph. The problem with this, though, is that it is only true for frames that are at rest or moving inertially.[5] It would not be the case for frames that are themselves accelerating.

When you speed up to pass another car on the freeway it can sometimes look like the other car is slowing down. If you considered yourself to be moving inertially then relative to you it would be. The speedometer in that other car will show that it stayed at the same speed and an observer standing next to the road will agree with that assessment and say that the other car stayed at the same speed while your car accelerated, but the Relativistic argument would be that from the perspective of your reference frame one could just as easily say that you are moving inertially and the other car is slowing down. If one were to object that more observers (such as the observer standing on the side of the road) would agree with the other driver than with you, Einstein would find that to be irrelevant. If you considered yourself to be at rest, which in Relativity one is always entitled to do because there is no absolute state of rest, then you could

[5] But then again, at rest or moving inertially relative to what? All other frames? It couldn't be at rest relative to all other frames or it would be the absolute state of rest. I don't think that the distinctions between accelerating frames, rest frames, and inertially moving frames would even hold up based upon these assumptions because there would be nothing to compare the motion with except the relative motion of other frames.

say that the other car is backing up, moving in your direction at the speed of the acceleration, similar to if that car was in reverse. Hence, observers could disagree over which frame accelerated.

If two bodies of reference accelerated at exactly the same rate and in the same direction (side by side) they would each be at rest relative to the other but accelerating relative to other frames.

It is also possible for observers to disagree over how much a reference frame has accelerated. Suppose I accelerated by 5 kph (3.1 mph) while the car ahead of me accelerated by 10 kph (6.2 mph) according to the observer next to the road. Einstein would say that I could agree with this, but I am also entitled to consider myself to be at rest, the observer standing by the road to have accelerated by 5 kph, and the car ahead of me to have accelerated by 5 kph (in opposite directions). So did the car ahead of me accelerate by 5 kph or 10 kph? Einstein would say that the answer is relative to the frame of reference and how observers choose to interpret the motion.

What if two cars were accelerating in opposite directions? Suppose that a car passes me going the opposite way on a two lane road. An observer standing on the side of the road would judge both my car and the other car to be accelerating by an equal amount. But if I considered myself to be at rest then I would judge the other car to be accelerating by twice as much as what the observer standing next to the road would calculate.

Finally, let us suppose for the sake of argument that acceleration was absolute. In that case observers obviously would not be able to consider themselves to be at rest while they are accelerating. So, we are saying that while a car is accelerating up to 100 kph (62.1 mph) the driver must know that the car is moving, and therefore would trust what the speedometer tells him about how fast he is moving, but then once the cruise has been set and the car is moving inertially he instantaneously stops trusting the speedometer and could then just as correctly consider himself to be at rest? Is the observer stupid? How could he not know that he is still moving? A body in motion stays in motion unless some outside force acts upon it (law of inertia); knowing that, and knowing that he accelerated up to a certain speed, and not detecting any outside force that has caused acceleration or deceleration after he began moving inertially at that speed (we already acknowledged he is able to detect acceleration), he would be able to deduce as an objective fact, if his acceleration was an objective fact, that he must still be in motion. He would not be entitled to regard himself as being at rest, even once the motion became inertial. Inertial motion would therefore have to be absolute as well. Either all motion is relative or none is.

A STRONGER TWIN PARADOX

To me it seems obvious that Einstein thought that acceleration is relative, just like inertial motion, and that is really the only view that is consistent with the claim that there is no preferred reference frame or absolute state of rest. But rather than continue to argue over acceleration, we could just modify the original thought experiment so that the twins experience an exactly equal amount of acceleration during the experiment.

Let's say that we have one ship that remains at rest throughout the experiment (we cannot choose earth because the earth is not stationary) and another that traces out an enormous perfectly circular path so that it completes exactly one revolution in 50 years. We will say that this ship is moving at .5c. We will also stipulate that the moving ship, ship A, got up to full speed before passing the stationary ship, ship B, and both of them start timing just as the two ships pass each other, and stop timing when they pass each other again 50 years later according to the stationary ship's time. The way that they pass is by having ship A fly 300 meters directly above ship B so that it does not have to alter its direction. We will assume that the circle that it completes will always be 300 meters above the circle that would exist for B. On each of these ships we have one of the twins: Andrew is on ship A and Benjamin is on ship B. We will also assume that the experiment takes place relatively far away from planets and stars so that the gravitational force is negligible.

The reason that the twins supposedly age at different rates is because time itself slows down, so all clocks in that reference frame would slow by the same amount, including a person's metabolism. As an example, if the ship was moving at .95c the prediction of the theory is that a crew member's metabolism would slow to only 4.5% of its normal rate. At extremes such as this, and given enough time, this would of course become very noticeable after awhile, but to be precise and ensure that they get accurate data we will say that the crew of each ship will also use a timer to keep track of exactly how much time passes for them during the experiment.

Once the experiment has been completed ship A will gradually slow down and come back to rendezvous with ship B and both crews will meet up on ship B to compare results and have a party.[6] What do you suppose their results will be?

Obviously the results that they are supposed to get is that the least amount of time will have passed for Andrew and his crew because they accelerated more than the other ship so time dilation affected them, whereas it does not affect Benjamin and ship B. One would expect this result because it was ship A that was moving at .5c whereas ship B was stationary. But since one is always allowed to consider himself or herself to be at rest, observers on ship A could just as easily say that it was actually ship B that was moving (despite not even having its thrusters on) and ship A was at rest. This results in a paradox because one could get the result that Andrew is younger than Benjamin but one could also just as easily say that Benjamin is younger because it was he that experienced the time dilation, and this answer seems to be just as correct according to the theory. Can they both be younger than the other one?

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[6] Perhaps someone might try to argue that Andrew still experiences more acceleration because he speeds up and slows down before and after the experiment. But this would not be true for the timers because they are only started and stopped once the two ships pass. Would the timers show different results than the age of the twins? Also, who is to say that it is Andrew speeding up and slowing down rather than Benjamin?

This is stronger than the original Twin Paradox because ship A does not have to change its speed at all during the experiment and the only change of direction would be the gentle arc of the circle. It is true that it accelerates because of this change in direction, but it is not clear which ship accelerates more because if observers on ship A were to consider themselves to be at rest they would say that they had experienced no acceleration at all during the experiment, as they think they were at rest the entire time; according to them it was only ship B that moved so they would think that ship B had experienced all of the acceleration and time dilation.

Since observers on each ship could disagree over which ship was moving and which was at rest it is unclear whether Andrew or Benjamin would have aged less, or whether they would both think that the other had aged less than himself. The only answer that is consistent with the Principle of Relativity (see section 9 beginning on p. 35) is the latter: both Andrew and Benjamin, along with their respective crews, would see the other as having aged less than themselves. Everyone agrees that both would see length contraction that way. It is never the case that an observer would perceive the length of his own reference frame, or anything in it, to be contracted. Observers always perceive their frame, and everything in it including themselves, to be ‘normal’ and the Relativity effect to occur in the other frame. That would only happen for ship A if they thought of themselves as being at rest because if they knew that they were going .5c they would expect time dilation to be happening in their frame, so, knowing what to look for, they should be able to perceive it by looking at what is happening in other frames around them. If time is slowing down in their frame then it stands to reason that they would perceive time in other frames to be speeding up even if their time continues to appear ‘normal’ to them. But if they know that they are moving at .5c they would know that they were the ones being affected by time dilation, not the other frames, especially if the amount that time appears to speed up in other frames is consistent with them moving at .5c.

The inverse is also true: if they can perceive any effects of time dilation for their reference frame at any point then they could deduce that they must not have been at rest and the Principle of Relativity would be violated. If you say that one can perceive time dilation to have occurred in his or her own reference frame then you are tacitly acknowledging that this observer knows with certainty that his or her frame must have been moving. (Assuming that one could discount the possibility that it was due to a higher gravitational field.)

If Andrew really did see Benjamin as having aged more than himself then time dilation must be invariant across all reference frames, meaning that observers in every reference frame perceive time dilation effects the same way regardless of the motion of their own frame. If that is true then ship A’s motion must be invariant as well because that is what caused the time dilation that every observer perceives. Thus the observers on ship A would not be entitled to consider themselves to be, or to have been at rest.

Furthermore, one could then use time dilation to determine the absolute motion of each frame, including his own. (According to the General Theory of Relativity one would have to account for gravity, but that could be done.) It would have to be the case that Andrew and the other members of his crew saw time speed up for ship B during the experiment, which is why he sees Benjamin as being older than himself. The closer that ship B got to the speed of light the more that the crew would judge the clocks in other reference frames to have sped up, just as observers in those reference frames would observe ship B's clocks to be running slower. This would be a way of being able to detect the absolute motion of your own reference frame. If time dilation is invariant then whenever you observed time to move slower for another reference frame than it does in yours you would know that this frame must be moving faster than yours, and if time moves faster for that frame than it does in yours then you would know that frame must be moving slower than your frame (again, discounting gravity). Comparing results from several other reference frames would allow you to estimate your own speed based upon time dilation even if you could not tell in any other way. But once again this contradicts the Principle of Relativity and the claim that one is always allowed to consider oneself to be at rest. There would be absolute motion and comparing the amount of time dilation that occurs in various frames would reveal it.

It is for these reasons that the only answer which is consistent with the Principle of Relativity and the theory as a whole is to say that both brothers, and their respective crews, see the other as having aged less than himself. (Or at least they both could; we'll come back to that issue later.) This means that ship A and ship B would also disagree over which ship had the most time pass: Andrew and his crew would think that more time had passed for them, while Benjamin and his crew would perceive more time to have elapsed on their own timer than on ship A's timer. So when Andrew looks at Benjamin's timer he must see a different number than what Benjamin sees when he looks at it. I don't see any other way it could be. Does that make it self-contradictory?

The Twin Paradox is often thought to reveal a self-contradiction in the Theory of Relativity, but to be fair, I do not think that it is a true self-contradiction to say that both brothers perceive the other to be younger than himself. The results are contradictory, but not self-contradictory. Logically, it is not problematic to have two contradictory statements, it is only problematic if the same statement is self-contradictory. In this way the theory is similar to Cultural Relativism. Perhaps in society 1 stealing is considered to be morally wrong while in society 2 it is not considered morally wrong. The two cultures contradict each other about whether stealing is wrong but that is not logically problematic for the theory of Cultural Relativism because according to that theory there is no absolute universal standard of right and wrong. So, one could just say that stealing is wrong, or judged to be wrong by the members of society 1, and not judged to be wrong by members of society 2. In other words whether stealing is wrong can only be answered relative to a particular society. Therefore it is not self-contradictory to say that for society 1 it is, and for society 2 it is not. The only way that it would be self-contradictory is if one of the two societies said that stealing was both wrong and not wrong in their culture.

Einstein's Theory of Relativity has some significant differences with Cultural Relativism, of course, but it is similar in the respect that both theories assert that there is no absolute universal standard of comparison. In Einstein's theory there is no absolute motion, no absolute state of rest, and no absolute time. If that is correct then it would not be self-contradictory or internally inconsistent to say that the observations of each crew contradict the other's account. You would just say that the crew of ship A has observations that are true for them, and B has observations that are true for them. To argue that it is an absurdity for both to perceive the other as having aged less (or in other words both of them perceive time dilation to have occurred for the other one) presumes that both are younger than the other in terms of absolute time, but of course absolute time is something that Einstein specifically rejects. It is a weird counterintuitive result, but it is not self-contradictory. In fact, that is the only solution in which the theory does not contradict itself.

Nevertheless, it is important to recognize just how weird it is. Imagine that the twins were 40 years old when they started the experiment and a couple of years after it is finished Benjamin dies of natural causes incident to old age, at 92 years old according to ship B's time. Or at least he does according to the crew members of ship B, but what would Andrew and the crew of ship A perceive? If less time passed for ship B because of time dilation, and Benjamin was significantly younger than Andrew according to ship A's reckoning of time, how could they perceive him to die of old age before Andrew does? Perhaps they don't.

Let's imagine the funeral. The crew of ship B mourning for their fallen comrade, while the crew of ship A sees Benjamin there at his own funeral because for them he has not died yet. (They must see younger versions of all the crew members of ship B that attend, who would not be mourning because Benjamin has not died yet for them.) Perhaps Benjamin even delivers the eulogy. Nobody from the crew of ship B can see or hear him (the older version), but Andrew and the crew of ship A assure them that it was very special. They could record it as long as they used a recording device from ship A, but unfortunately the crew of ship B (the old version of them) won't be able to see or hear it. That is too bad, because Benjamin gives a very emotional heartfelt tribute to himself. He says: 'We're all gonna miss you big guy. Especially me.' Then he breaks down in tears while old Andrew (the one that crew A sees) tries to comfort him. Young Andrew (the one that crew B sees) would also try to comfort him if he was able to perceive young Benjamin, or old Andrew. Or perhaps old Andrew and young Andrew occupy the same space and are the same person and he just looks different to the members of each crew. If that is the case I have no idea how he or the other crew members would perceive Benjamin. Is Benjamin lying in the casket or standing at the podium giving the eulogy? (If it is a closed casket perhaps Schrödinger's cat is in there as well; I guess we have to say that it both is and isn't until somebody opens the casket to take a look.)

We have two different versions of time, yet somehow they can interact with each other. Well, sort of, anyway, but do they really if crew A looks at ship B's clocks and calendars and their timer and perceives something different than what crew B sees when they look at them? I don't know. It is unclear how these fractured overlapping timeframes are supposed to fit together, and why simply moving at a high speed would cause this permanent fracturing of time.

Why isn't time dilation like length contraction? Recall that length contraction reverts back to the so-called 'rest length' once the reference frame slows down. If you had a measuring rod of one meter that accompanied the crew of ship A the Theory of Relativity says that it would have contracted while they were traveling at .5c but it would revert back to being a meter long once it was at rest on ship B and crew members from both crews would measure it to be the same length. (Actually, the crew of ship A would think that it was never any other length because when it was contracted they were contracted by the same amount.) So why is time dilation supposed to be a permanent irreversible effect of moving at .5c but length contraction is not? Why wouldn't time become synchronized again once both crews were back together in the same frame of reference?[7]

If an experiment like this were ever done in real life it would definitely be artificial intelligence that performed it. There would be several advantages to doing it that way. First, humans would probably not want to dedicate a good portion of their lives to performing an experiment like this, but they might be willing to send robots and/or unmanned vessels to do it. Secondly, there would be potential health risks. The vessels themselves could endure much greater g-forces than people without being damaged, especially if they were designed specifically for that purpose. But the main reason is that the time could be tracked much more precisely than by trying to tell how much a person has aged. This would mean that one could perform the test in less time and at much lower speeds with artificial intelligence.

Let's do the experiment again, this time using artificial intelligence. We could use identical androids as our 'twins' but there is no need, we can just use the ships themselves. Imagine that we have a very large circular track. There are three starships unimaginatively labeled A, B, and C. Ships A and B are out at the circumference of the circle while C is at the center and will be at rest relative to the other ships.

Ship A is 300 meters directly above ship B in the vertical or y coordinate plane so that the ships can pass each other without having to change direction. There are sensors on the bottom of ship A and others located at the top of ship B that will detect when the ships pass each other.

Each of these 'observers' would have an internal chronometer that would track how much time has passed for them from the beginning to the end of the experiment. In addition to this several other time-keeping devices could be placed on board each ship to corroborate how much time has passed as a cross-check to the ship's computer.

We will now assume that ship A accelerates to .75c and maintains that speed while ship B accelerates to .25c and also maintains that speed, both in the counterclockwise direction.

To alleviate any concerns that ship A experiences more acceleration while getting up to speed we will say that they only start the experiment once both ships are at full speed. None of the ships

[7] I think I know the answer to that question, actually. It is because time dilation is tied to gravity while length contraction is not. In the General Theory of Relativity stronger gravitational fields are thought to cause time dilation as well. But why couldn't time revert back to how it was once the observer was back in a weaker gravitational field, similar to a measuring rod returning to its 'rest length'?

start to time themselves until they have confirmed with each other that both A and B are up to speed and ready to begin; then, as previously agreed, all three begin to time themselves on the next pass of A and B. For both A and B the timer starts as soon as the sensors detect the sensors on the other ship. Ship C would be tracking the acceleration, speed, and position of the other two ships all along, which would also be in accordance with a previously agreed upon plan (and programming), so that computer could calculate pretty accurately when ship A will pass ship B; ship C's computer starts its timer when it estimates that this has taken place.

Let's say that they keep going for 10 full days according to ship C's time. Then ship C sends out a signal to the others, and once both have confirmed that they received it they all stop timing when the two ships pass each other the next time. They will all keep track of the time while both ships are slowing down, but this will be categorized separately from the time that was kept during the experiment.

What do you suppose the results would be? One might assume that the least amount of time would have passed for ship A during the experiment because, the thinking goes, it experienced the most acceleration. But we cannot really say that because according to Relativity observers on each ship (A and B) could regard themselves as being at rest and the other ship as moving at .5c; thus each would consider its own time to be 'normal' and would think that time had slowed down for the other ship because to it the other ship was the only one that was moving.

One could not say that either ship was ever moving inertially, even though they maintained a constant speed during the experiment, because for both of them the ship's computer would have to continually change the direction to keep it moving in a circle. But if ship B saw itself as being at rest then it would see A as moving around the track at .5c in a counterclockwise direction, if A considered itself to be at rest it would see B as flying around the circle at .5c in a clockwise direction with a backwards orientation. So which one accelerated during the experiment? According to C they both did because both were moving; according to A it was B that accelerated, according to B it was A. Relativity says that all accounts are equally correct.[8]

In the original Twin Paradox a ship leaves earth, accelerates up to speed, and then at some point slows down (presumably), turns around and comes home, once again speeding up and slowing down; all of the proposed solutions to the paradox utilize in some way the asymmetry of this twin's motion in comparison to the motion of the twin on earth. But in this case how observers on each ship, A and B, view the motion of the other would be completely equivalent, it would just be inverted. (If they considered themselves to be at rest.)

I am not entirely sure how ship C would fit into the picture; could the other two ships really consider it to be moving and themselves to be at rest? I don't see how, because it is located at the

[8] But it is only possible, not necessary that each ship considers itself to be at rest. Suppose that ship A agreed with C's account that it was moving at .75c; well then A has a completely different answer, which apparently is also equally correct. So does A's reckoning of time depend upon an arbitrary choice of whether it considers itself to have been moving or at rest? Or are both answers supposed to be true?

center of the circle while they are out at the circumference. They most definitely would not think that ship C was moving in a circle around them at .25c, .5c, or .75c, even if they did think that they were at rest. I wonder if maybe what Einstein would say is that observers on ships A and B would see ship C's orientation change as they went around the circle, but maybe he thinks that they would attribute that to ship C slowly spinning in place rather than thinking that it meant that they were moving around it. But would it really be true that they could not tell the difference between going around a stationary ship and seeing it spin in place while they were stationary? I have serious doubts about that. There would likely be some detectable differences between those two scenarios that the computers on board A and B would be able to pick up. Apparently we must also be assuming that there are no stars or planets visible that would help the ships to orient themselves because if there are they would be able to tell when they are moving and when they are at rest. If time dilation was real they could also check how fast time is moving on ship C in comparison to their own ship during the experiment. It should run at very nearly the same speed or slightly slower if they are stationary and it is slowly spinning in place, but it would run faster on ship C if it is at rest and they were moving at either .75c or .25c.

I said earlier that both twins seeing the other as younger than himself does not result in a self-contradiction, it merely results in contradictory claims by observers in different reference frames. In other words it is not equivalent to asserting 'P and not-P' unless Benjamin is both dead and not dead within the same frame of reference, and that is not what is being asserted. But there is another problem which does actually result in a self-contradiction. How much time has passed for each ship? Did A travel at .75c and B at .25c, or did A move at .5c while B was at rest, or was A at rest while B moved at .5c? Did C move, or was it stationary the whole time? If B considers itself to have been moving at .25c during the experiment then it will have experimental results that correlate with the appropriate amount of time dilation for moving at that speed, but what if ship B considers itself to be at rest? Are we saying that then it will not have experienced any time dilation if it considered itself to be at rest? Will there be a different amount of time that has passed in B's experimental results if it considers itself to be at rest than if it considers itself to have been moving? If it was at rest the whole time then it should have results which show that it had a roughly equivalent amount of time pass as ship C, which it sees as slowly spinning in place because this spinning would have practically no effect as far as time dilation. B would always see ship A as moving at .5c faster than it did, but how ship C is perceived would depend upon whether it considers itself to have been moving or at rest during the experiment. So which is it?

Also, would the computer of ship B say that A was moving .5c faster than ship C, or .75c faster? That would, of course, make a big difference in how much time was slowed when comparing A to C. Is B going to get two different results for how much time passed on each of the other ships based upon whether it perceives itself to have been moving or at rest?

What if ship B agreed with A's account rather than C's and considered A to be at rest while it moved at .5c? I don't see why it would be prohibited from doing that. In that case B would recognize that time dilation occurred in its own reference frame and would thus perceive the most amount of time to have passed for A, since it was at rest, and C's results would be close to

A's because it was only rotating or completely at rest. (Here is another inconsistency: A would see it as rotating slowly because A thinks it is at rest, and B is supposedly agreeing with that account, but B also sees itself as moving at .5c, so it should attribute the supposed motion of C to it moving around the circle at .5c, not C rotating.) Ship B could perceive itself to have had a speed of .5c, .25c, or none at all. So which of these will B's experimental results be correlated with? Will ship B's computer agree with what you as an outside observer will see when you look at the results and compare it with the results from A and C? Will ship B have different experimental results depending upon whether it considers itself to have been moving or at rest? How much was time slowed, if at all, for B? What the hell is going to be on that timer?

This problem is serious because we get different answers that are supposed to be equally correct for the same reference frame. That does result in a self-contradictory claim.

With the Twin Paradox everybody focuses on the issue of which twin is younger, but actually we don't even need to worry about that to identify the problem. If we go back to the prior scenario, the issue is that if Andrew is aware of and acknowledges that he is or was moving then he would be younger than himself, the age that he would be if he considered himself to have been at rest the whole time. Since both answers are equally correct, according to the theory, we get the self-contradictory result that Andrew is younger than himself.

This problem is not limited to the Twin Paradox scenario either. Any time that a reference frame is moving it would cause some amount of time dilation but if observers within that frame considered themselves to be at rest, which one is always entitled to do according to the theory, then there would be two different but supposedly equally correct answers for how much time passed for that reference frame. Did time dilation occur for that reference frame or not? It did if the frame was in motion, it did not if the frame was at rest. The theory is committed to saying that it both did and didn't, depending upon how the observer chooses to interpret the motion. This is equivalent to having the same society say that stealing both is and is not morally wrong, or that it is both 1:04 p.m. and 3:07 p.m. in the same time zone.

One way out of this dilemma would be to say that all observers must always consider themselves to be at rest, but that would mean that no frame would ever have time slow down, at least from the perspective of that frame. Einstein did not think that one is required to always consider herself to be at rest, only that she could (and if he had said that it was required that would clearly be false). This means that B could have experimental results which show that more time passed for it than A during the experiment, but it could also just as correctly have experimental results that show less time passed for it than for A (if A was at rest); the results could show that less time passed for B than for C, but they could just as easily show that roughly an equal amount of time passed for both ships, just depending upon whether B considered itself to be at rest.

I think we need to seriously consider whether these results are even possible, let alone reasonable. If the computer changed its mind during the experiment and went from saying that it was moving to instead considering itself to be at rest would the numbers on all of the additional time-keeping devices that are on board, such as atomic clocks and digital watches suddenly change to reflect this? How can anybody believe that this is actually true?

TIME DILATION IS FROM 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?

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 speed. 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 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 perspective 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. (It would reach the observers 8 seconds earlier than if both ships were stationary.) This is equivalent to time appearing to speed up for the other reference frame 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 though, 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.

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 slowed down or sped up. Everyone would have aged by the same amount, and it would be no different in terms of time 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, 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 long distance away? Why?

Moreover, Relativity 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 (at least) 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 toward them at .5c. 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 (because it was the one moving at .5c while the other was stationary), 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 based upon measuring the amount of time dilation and comparing it with other observations to figure out with certainty which ship was moving. (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 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 toward 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' while their observations of the other ship are affected by Doppler shift because of the high speed and the great distance.

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?

I should pause here to note and respond to an objection that someone defending Relativity could possibly make. Perhaps an apologist would argue that Einstein could account for the direction of the ship and that he would not really be committed to saying that the signals would be longer than 10 seconds because the ship is closer to the viewer when the new signal is produced, which would offset the slowing of time that occurs because of time dilation. Thus, he or she might say, Einstein would not be committed to saying that there would be a greater than 10 second interval between the beginning of a light flash to the beginning of the next one, he would only be committed to saying that it would be greater than 5 seconds because of the time dilation. (The Relativity defender would have to at least acknowledge this, because it would be a 5 second interval between the signals if there was no time dilation for the ship at all, so at the very least Einstein would be committed to saying that it would be longer than 5 seconds.)

Okay, fair enough. I explained it the way that I did to emphasize that it is the ship's direction which determines whether time appears to speed up or slow down for it, and that the time of the signal ship would only appear to slow when it is moving away from the observers. But we could account for this potential objection without much trouble. I am saying that if the ship producing the signals is moving at exactly half the speed of light a 10 second interval from the beginning of one light flash to the beginning of the next one when the ship is at rest would shrink to an interval of exactly 5 seconds, whereas, according to this line of argument, Einstein's claim would be that it must be a little longer than 5 seconds because of time dilation. It would also be the case that whereas I predicted that the interval between the signals would increase from 10 seconds to exactly 15 seconds when the signal ship was moving directly away from the stationary observers Einstein would be committed to saying that it has to be more than 15 seconds. Those are still testable predictions that would decisively prove whether there is time dilation for that reference frame or not.

If the signal ship was moving faster, say .99c, then the time dilation would be much more extreme and the difference between my predictions versus Relativity's predictions would be much greater. That would make it easier to test. The problem is finding an object that does something at a regular interval that is easily visible from far away, such as the light flashes every 10 seconds, and then getting that object moving fast enough so that there would be significant time dilation predicted by Relativity. Assuming that it continues to do that same thing at the same regular interval whether it is moving or at rest, this could act as our 'clock' or a way of being able to tell time for that reference frame even from other reference frames that are a long distance away from it and even if we are not moving nearly as fast. I hope that one day an experiment like this can be done in real life. I am very confident about what the results will be.

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 weird preoccupation with the speed of light. There is not actually anything particularly special about that speed, it is just the speed at which electromagnetic waves happen to propagate. But Einstein and the scientists of his day thought that nothing could exceed the speed of light and this is a big part of the theory.[9]

Similar to Lorentz's view, Relativity 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, known as 'inertial mass' is rather mystical. It is not the regular mass of the object, which Relativity refers to as the 'rest mass'. The so-called 'rest mass' does not change depending upon the object's speed.

The whole concept of 'inertial mass' seems ad hoc.[10] 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 (which is probably what Einstein's view is based on) that the particles become more massive as they are contracted into a smaller space because they are not actually contracted.[11]

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

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[9] Some more recent theories assert that there could be particles, called tachyons, that do actually move faster than light. According to this idea 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. Proponents argue that this is still in harmony with Relativity but many scientists do not accept it. As of the time of writing tachyons are still considered merely hypothetical.

[10] There is also a similar problem to the one just raised in the prior section. If observers in a reference frame that was moving considered themselves to be at rest instead then they would get a different answer for the inertial mass of every object in the frame than it would be if the frame was considered to be moving. Obviously the inertial mass would have to be zero if the frame was at rest. According to the theory both answers would be true. But how can an observer in the same reference frame have two different but supposedly equally correct answers for how massive something is? A related question is how could an observer really consider himself to be at rest if he can observe or calculate that the inertial mass of an object within his frame is greater than zero?

[11] Some sources on Relativity use nuclear power as empirical 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 very suddenly in an uncontrolled 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. I will talk more about the claim of mass-energy equivalence in a later section.

increased drag, reduced controllability, etc. There may 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.

I don't see why a regular object could not be accelerated to a speed greater than the speed of light. There is nothing uniquely special about that speed. It is just the speed of a wave. 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 the speed of light? The biggest challenge in doing it 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 somewhere around eight and a half minutes for the light emanating from the sun to reach earth (depending upon how far away the earth is, which varies). If the earth was moving away from the sun at the exact same speed as this light then 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 new crests or troughs 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. This latter result is because the light reflecting off of distant objects and bouncing back towards you would reach you in half of the time that it would ordinarily take.

Now suppose that we have a viewer that is stationary and a spaceship that is moving directly 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. The changes that are actually taking place on board would be observed much more slowly because of the ship's speed and direction away from the observer. 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 to the observer, 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 backwards. But this is not actually the case. Once the light is emitted it has its own independent velocity and propagates from the location where it was emitted rather than the current location of the source, so even if the ship was the light source the light 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. Observations would be delayed if the ship was moving away from the observer at faster than the speed of light because the observation can occur no faster than the light that brings it to the observer, and the image of the ship could become greatly distorted, or it may just be a flash of light, but the observer would see something and it would never seem like time had entirely stopped or began to move backwards for that ship.

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. (If it was moving toward you or in a roughly parallel direction.) 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 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. The ship could be far ahead of the light waves but there would be no way for an observer at a significant distance away from the ship to detect its actual location until it slowed down.

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 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.[12]

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. 1 would represent an object at rest relative to the sound wave. The numerical value would shrink towards zero until it broke the sound barrier, at which point it would turn negative.

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

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[12] I wonder if perhaps these optical effects could account for some of the things that are observed in quantum mechanics. Certainly it does not account for a lot of the quantum weirdness, but it might explain a few things, such as particles seemingly appearing out of nowhere or suddenly disappearing. This might be because they are being accelerated to move faster than light or slowing down to a speed lower than light when they were previously moving faster. If they do that it would create all sorts of strange optical effects for the observer. Because the particles are so small they could be accelerated and/or moved off course very easily by the particles that make up the medium as well as other particles that are in their path and thus their speed and direction would be practically impossible to predict accurately without more information. You could come up with an approximation statistically, but not the path of an individual particle, which of course is what is observed.

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 Einstein accounted for a scenario like this. If those on ship A were to measure the speed 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 always remain below the speed of light for all observers.) The same would be true if observers on ship B were to judge A's speed. 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 relative to the observer. From the stationary observer's point of view both ships are measured to be moving at .7c, but observers on those ships will measure it differently.

I will address Einstein's claims about the relativity of motion in section 9 on the Light Postulate, but I believe that what would really happen in this case is that the observations 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.

Let's return to the three ships on the circular track mentioned in section 5. The Theory of Relativity says that it is possible for ship A to go .75c and B to go .25c as long as they are both going in the same direction around the track. But suppose that A goes at the same speed in the counterclockwise direction while B moves clockwise around the track. Is this impossible? I don't see why it would be. If it is possible for B to go .25c then it seems like it should be able to do that in any direction regardless of how fast A is moving (unless of course A somehow affected it directly). But if no material object can meet or exceed the speed of light then no two material objects could have combined speeds that reach or exceed the speed of light. If they could then either one of them could consider themselves to be at rest and the other ship as moving around the track at the speed of light, which is supposed to be a physical impossibility. No doubt Einstein would want to use his 'reduction factor' here, but is it really warranted? Aren't both ships actually moving at .25c and .75c just as they were when they were both going the same direction?

Recall that the explanation for why an object cannot be accelerated up to or beyond the speed of light was that its mass increases as its speed increases so that it becomes infinitely massive as it approaches the speed of light; it is therefore impossible to ever have enough energy to accelerate it up to and/or beyond that speed. Apparently the same thing would happen at .75c and .25c if the ships are moving in opposite directions around the track. But why? Why would A have more inertial mass at .75c when B is moving in the opposite direction than it would have at .75c when they are both moving in the same direction? It is one thing to say that B's motion causes B to become more massive, it is quite another to say that the motion and direction of B cause A to become more massive. This would also mean that when they are going the same direction that the inertial mass of A decreases and the inertial mass of B increases from what it would be if that was the only ship on the track because in that case each could consider themselves to be at rest and the other to be moving at .5c. But do they see it that way or do they think of themselves as moving? That apparently will determine how much inertial mass the ship has. When the computer of ship B measures the mass of ship A, would it find the inertial mass to be consistent with ship A moving at .75c, .5c, or 0?

Would it be possible for one ship to go .51c in the clockwise direction and the other to go .51c in the counterclockwise direction? It sure seems like it would, but if either one of them considered themselves to be at rest then they would have to see the other as moving at 1.02c around the circle. So now we are saying that not only can an object not exceed the speed of light but it cannot even go .51c in certain directions, depending upon the speed and direction of other objects?

I would guess that Einstein would respond to these scenarios in a similar way to the one earlier, by using a reduction factor to say that each ship would calculate the speed of the other in such a way that it would not equal a speed above the speed of light, but it seems strange to think that the reduction factor would not be needed when they are both going in the same direction yet it would be needed if they are moving in opposite directions around the circle.

Suppose that two ships were traveling abreast of one another at .51c. The theory suggests that this is at least theoretically possible. But why would it not also be possible for those same ships to go the same speed if they were instead some distance away and moving toward each other? In that case each could consider themselves to be at rest, but according to the theory they would not consider the other ship to be moving at 1.02c, it would be some speed that is slower than the speed of light. I think it is a legitimate question to ask why the direction of travel would make such a difference in terms of how the observers measure the speed of the other ship. Is the reduction factor really justified? What if the length contraction that is observed for the other ship is consistent with it moving at .51c and the observer recognizes her own ship to be moving .51c?

RELATIVISTIC TIME TRAVEL

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. 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 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 actually 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 because they beat the light to that spot 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.

Suppose that one of the astronauts wanted to see himself on earth as a child. It would be theoretically possible if they could beat light to a particular spot in space where that could still be observed all those years after it occurred. It would of course be many light years away from earth. This would be no different than emitting a really loud sound yourself and then racing to a spot 10 km away and being able to hear that same sound or pick it up with instruments from that vantage point. If you could beat the sound waves to that spot 10 km away you could do that, but of course it would be very difficult to actually do this, even for sound waves, let alone light waves.

It is unclear how much observers would be able to see while they were moving faster than light. Objects that were close by would probably just be a blur. But stars and other distant objects would most likely still be visible to them, at least in the direction of travel.

THE LIGHT POSTULATE

The speed of light is important in the Theory of Relativity in another way. In what has come to be called the 'Light Postulate' Einstein claims that all uniformly moving observers (which would include those at rest) must measure the same speed for light. In an example that he gave, Einstein 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.

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 and/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 inertial reference frames.[13] 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 (and towards them) at c, since the speed of light is taken to be a law of physics.[14] 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.

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[13] 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 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 the Theory of Relativity the harder it becomes to ignore the fact that Einstein obviously 'borrowed' (to be very charitable) some key ideas from others without always citing his sources. Especially Poincaré. 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. I subsequently checked several other sources on the subject, including reading from an English translation of Poincaré's actual book, and found this source to be accurate.

[14] See chapter 7 'The Apparent Incompatibility of the Law of the Propagation of Light With The Principle of Relativity' in *Relativity The Special and General Theory*.

In defense of this, a Relativity apologist 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 slow down for an observer in motion, 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 for you in the direction of motion. 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 speed as well rather than considering her to be at rest. 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.

Einstein did not think that there was any such thing as absolute motion or an absolute state of rest so he seems to have thought that the Principle of Relativity required that the motion of all reference frames be set to zero from the perspective of that frame. The observers that are within that frame would attribute any motion that is observed or otherwise detected to other reference frames moving instead of their own. I say this because that is the only explanation for why Einstein thinks that the observers would always measure light to be traveling away from them at the same speed in all directions: that is what they would observe if they were completely at rest. 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 consider themselves to be at rest even if according to other frames of reference they are moving.

We have discussed this claim quite a bit already in previous sections. Apparently it seems intuitively plausible to some people. 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 kph) while you and the car are motionless.[15] According to the Theory of Relativity they are; that is an equally correct way of describing the motion as to say that the car is moving and those objects are stationary. If you were to object and say that one description is correct and the other only appears to be so Einstein would insist that both are equally correct and that there is no non-arbitrary way of

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[15] However the reverse is not true; I have never thought that I was moving while in fact I was at rest. I have never been standing motionless and then when I saw a car pass by at 100 kph thought that maybe it was stationary and that I was in fact the one moving at 100 kph. I doubt that anyone else has either.

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 hang on a minute, nobody really thinks (not for more than a second or two anyway) that the car they are riding in is actually stationary while everything else is moving around them instead. 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 it once the motion became inertial. Unless they had been moving at that speed and in that same direction for their entire lives they would remember accelerating. As I said in a previous section, if they are familiar with the law of inertia (Newton's first law of motion) and they know that they previously accelerated they would be able to deduce that they must still be in motion if they have not detected any deceleration. I suppose you could say that it is really everything else that is moving, and you are stationary, and that may seem plausible to you if you are on drugs, but rather implausible otherwise. In fact it is actually pretty silly.

Einstein did think (drawing inspiration from Poincaré) that no law of physics or anything else would tell an observer whether they were moving or at rest, but that just seems blatantly false. To me the stronger claim is that if there is no absolute state of rest observers in any reference frame would be just as entitled to consider themselves to be at rest as anyone else. Let's address that one more directly.

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 matter because all of the motion that we are referring to is contained within the universe. This would be like comparing the motion of objects that are contained within a 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, and it must be by observers within the frame, according to the theory, regardless of whether the frame is in motion or not relative to bodies outside of the frame, then you could compare the motion of every object within that frame to the coordinate system associated with the frame itself to get an equivalent of absolute motion for all the things within that frame. (One could not claim that the reference frame is moving instead of the object that one is comparing it with, or the observers, since the frame is taken to be at rest.) For example, 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 of those objects to each other, 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. Observers within the reference frame may perceive events differently than other observers do based upon their position, or if they are moving, but they would be able to tell when they are moving relative to the reference frame. Since the frame's motion is taken to be zero, any motion that they experience is their motion.

If we do this with the universe we have something similar to Newton's absolute state of rest, at least relative to our universe. If we added a time element then we would have the 'space-time' 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 universe as whole, which for us is equivalent to being absolute.

Moreover, insisting that c is the maximum speed for objects implies an absolute state of rest. We could infer that if you were in a spaceship that was traveling at the speed of light and you considered yourself to be at rest the objects that were rushing past you at c would actually be in a state of absolute rest relative to light. You couldn't go any faster, which means they could not be any more at rest relative to you and to light. 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 it would be, and we would know that it must exist. Not only that, if all observers in every reference frame always measure the speed of light to be c in every direction regardless of their own motion, as the theory purports, then this would have to be considered absolute motion.

Is it really justified to treat light waves so differently than any other kind of wave? If observers in all reference frames could always consider themselves to be at rest then 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, your speed would always be zero.

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, I do not contest that, 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, and they (meaning the observers) acknowledge that they have a speed 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 should make though. 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 the 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 the motion 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 inside the ship would perceive 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 measure the light in the direction of their motion as moving away from them at .001c and 1.999c in the opposite direction (light on the other side of the expanding sphere). It would be no different than an airplane 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 speed and subtract that from the speed of the wave. (Assuming that he is moving slower than the wave.)

Let's suppose that we have two spaceships moving in the same direction, one at .99999c and the other at .99998c. We will say that the faster ship is behind the other one and it passes right by the slower one as it moves ahead. If you were on board the slower ship Einstein would say that you would perceive the other ship to be moving at .99999c but you would still think that the light moving away from you in the same direction was moving away from you at c. So would the other ship be moving ahead of you at .00001c or .99999c? Honestly, I don't know what the answer to that is supposed to be. If you considered yourself to be at rest it would be .99999c, if you recognized that you were moving it would be .00001c. Obviously it would look a lot different to an observer if the other ship passes him at a speed of .00001c than it would if it passed him at .99999c while he was stationary. If the observer perceives the speed of the other ship to be .00001c then how would he account for the extreme length contraction and time dilation that the theory predicts he would see for the other ship which would be consistent with it going .99999c? But perhaps he does not see that; maybe he sees time dilation and length contraction of the other ship that would be consistent with it moving .00001c because of his own speed. Okay, so then would he say that the other ship is moving .00001c slower than the speed of light or .99999c slower? It seems like it would have to be the latter, both because he would have to see himself as being at rest in order for light to move away from him at c in that direction, and because he thinks that the other ship is moving at .00001c because of how he measures its speed relative to himself and its time dilation and length contraction, which we said was consistent with it moving at .00001c. But that makes no sense. If the speed of light is a constant for all observers, regardless of the reference frame, then all other reference frames should also be able to perceive that ship (other than on the ship itself, where observers could think of themselves as being at rest) to be going only .00001c slower than light. Why can observers in other reference frames all measure the speed of light accurately as its true speed, regardless of the speed of their own frame, but they cannot measure this ship's speed by simply measuring the difference between its speed and the speed of light? The observer's own speed does not matter because he could calibrate the other ship's speed relative to light which is invariant across all reference frames. Thus observers in every reference frame should measure the ship's speed as .99999c, including the one moving at .99998c.

On the other hand, if we say that the observer could measure the other ship's speed accurately, and the other ship passes him going .00001c faster, then why could he not then deduce that his reference frame must also be moving even if he could not tell in any other way? If we acknowledge that he is aware of his own speed then the light would have to be moving away from him in that same direction at .00002c if it is moving away from the other ship at .00001c, and the latter would have to be the case if he can accurately judge the other ship's speed to be .99999c. What Einstein is saying does not add up.

We will now take this thought experiment a step further. Suppose that both ships are abreast of each other going .99999c. They are not the same body of reference even though they both happen to be going the same speed. An observer on either ship would be able to tell that the other ship is going only .00001c less than the speed of light; he would have to be able to perceive that if he can tell that it is moving at .99999c. So how then could that observer possibly consider himself and his reference frame to be at rest if the other ship was staying abreast of his ship? Would observers perceive the other ship to have the extreme length contraction and time dilation that the theory predicts it would have but not be able to perceive it for their own ship when they are both going the exact same speed? How could an observer perceive the other ship to be going only .00001c slower than light, and thus the light moves away from that ship at .00001c in the direction of the ship's motion, while also perceiving light to be moving away from him at c in that same direction when his ship is going the exact same speed?

Let's now return one final time to the circular track described in section 5. I said in that section that there would be no difference between one ship moving at .25c while the other is moving at .75c and when one is at rest and the other is moving at .5c. That is true for one ship relative to the other, but of course it is not true for other reference frames, such as ship C. As I stated in that section, I do not believe that observers on either ship could legitimately consider themselves to be at rest. Not only would their observations of ship C be different if they were moving versus if they were at rest, but their observations of all the stars and distant planets, and every other reference frame that they could see would look different too. If sea captains were able to navigate and get their bearings using the stars and other celestial bodies surely a starship could as well.

If both ships were moving then they would be passing each other at different points on the circle, whereas if one was stationary then they would always pass at the same point. That would make a huge difference in how they would perceive everything else around them. I mean sure, I guess you could think that the stars and the planets and ship C and everything else is moving instead of you, but is it really reasonable to believe that? I don't think so.

The only way that an observer on one of these ships would really not be able to tell whether she was moving or at rest is if both ships had been moving the same way for the entirety of the observer's life so that she never knew anything else,[16] and if the two ships were the only two things in the universe that she could see. Then and only then could one maybe say that she would not be able to tell the difference between one of them moving at .75c and the other at .25c and one moving at .5c while the other is stationary. As soon as even one other reference frame is introduced, and especially if there are multiple reference frames, it would allow observers on each ship to gain their bearings and put the motion in context and then there is no way that they would not be able to tell when they were moving and when they were at rest. Under most conditions it would not even be a legitimate question.

Of course the same would also be true if the reference frames are moving in a straight line. When observers have other frames to compare themselves with, such as the distant stars, it allows them to orient themselves and determine whether they and/or the other body of reference is moving. It is not so much the observations of one's own reference frame that reveals the fact that it is moving it is the observations of what is outside of it. When I am in an airplane or car I do feel the acceleration but it is looking out the window that really reveals the fact that I am moving. It is like the Theory of Relativity ignores or forgets about all the reference frames except for those two, or it makes the assertion that the observer could just as plausibly believe that everything else is moving while they are at rest, which is simply not true. It is very clear when we are moving relative to the things around us and when we are not.

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. But that is exactly the pattern of reasoning that is used in the Theory of Relativity. The Principle of Relativity would commit us to saying that the perceptions of all observers in 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 Theory of Relativity would say both are for their reference frame. I admit 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

[16] The motion of the earth is sometimes brought up as an example of this. For much of recorded history some humans have been unaware of the earth's spin and its rotation around the sun. Some say that we are unaware of the motion of a reference frame when it moves inertially, but we can tell when it accelerates; however the earth is constantly changing direction, so it is not an inertial frame, which shows that an observer could be unaware of an accelerating frame as well. I do not think we would be able to feel a slight increase or decrease in speed either if it was very gradual. (The earth does change speed slightly as it moves around the sun.) Suppose that the frame constantly accelerated (speeding up or slowing down) by .0000001 m/s. If you had experienced that all your life it would seem normal to you and you may not even notice it. But I think you would be able to tell that you were moving in other ways. Even though we do not feel the earth's motion, in modern times we are still aware of it. There are ways to tell that the body of reference is moving besides just being able to feel the acceleration.

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 assume 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 the theory that is not correct. In Relativity there are no observer-independent facts about the world, only perceptions, and all perceptions are equal. If that was really 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 why think there would 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.

THE RELATIVITY OF SIMULTANEITY?

Einstein (likely inspired by Poincaré) says that measurements are based upon the concept of simultaneity, but he argues that simultaneity is relative, claiming that all measurements of space and time are relative to the viewer's frame of reference. This is why Einstein believes that observers in different reference frames could have differing but equally correct accounts of how long a measuring rod is or how fast time is moving. This is a key philosophical assertion that one must buy into in order to accept the theory. But I do not because it assumes that all observations from each and every observer in every frame of reference are all equally accurate and that is simply not the case. We know from experience that there are many instances in which an observer's perceptions of an event are different than the underlying reality. The fact that a distant observer does not perceive two events to have occurred simultaneously does not necessarily mean that they did not occur simultaneously in reality, and if the observer perceives them to have occurred simultaneously it does not necessarily mean that they really did occur simultaneously.

Sometimes our eyes and ears do not perceive events in real time. A person who is several kilometers away will notice a delay between when he sees a flash of lightning and when he hears the thunder. However we know from experience that when an observer is closer to that event he will perceive it to occur at very nearly the same time. The only reason that it is not observed that way from a distance is because light waves travel much faster than sound waves so the observer can perceive the event sooner with his eyes than with his ears. But it has to be the case that thunder and lightning occur very close to simultaneously, regardless of how it is perceived by a distant observer, because thunder is caused by the expansion of rapidly heated air and lightning is what causes the air to be rapidly heated.

In chapter 3 of *Relativity The Special and General Theory* Einstein imagines a scenario in which he is on a train that is moving inertially and he drops a stone out the window without throwing it. He says that he would see the stone fall to the ground in a straight line (as he looks behind the moving train) while a pedestrian who is standing on a footpath next to the train tracks would see the stone fall to the earth in a parabolic curve. He then asks: 'Do the "positions" traversed by the stone lie "in reality" on a straight line or on a parabola?'

I will give my answer to that question shortly, but first let's look at his own answer, which he gives a little bit further down:

> The stone traverses a straight line relative to a system of co-ordinates rigidly attached to the carriage [meaning the train], but relative to a system of co-ordinates rigidly attached to the ground (embankment) it describes a parabola. With the aid of this example it is clearly seen that there is no such thing as an independently existing trajectory (curve along which the body moves), but only a trajectory relative to a particular body of reference.

Einstein is looking at this as though the two reference bodies and the coordinate systems that are associated with them are incommensurable. He seems to be thinking of it as being true that the stone's trajectory is down in a straight line according to the coordinate system associated with the train and false that its path is parabolic, while it is true that the trajectory is parabolic for the coordinate system associated with the observer on the footpath and false to say that it moves down in a straight line.

I think perhaps part of the reason he is thinking of it this way is because the two coordinate systems would potentially be oriented differently based upon the direction that the observers would be looking. If I am facing someone my right hand side is opposite to their right hand side. This would be somewhat like that but in this case the observers would likely be standing at a right angle to one another. The observer on the train is facing in the same direction as the track as he looks behind the moving train while the observer standing on the footpath would be looking straight ahead in a direction that is perpendicular to the track. Thus, if the observer on the footpath sees the train coming from her right hand side and moving to her left then she will see the stone and its parabolic path moving from her right to her left. Obviously Einstein is correct in saying that the observer on the train will not see the stone move horizontally from his right hand side to his left.

While this is not necessary to harmonize the two views, it would simplify things a great deal if the two observers would agree to use the same coordinate system. It just makes communication between them much easier by avoiding misunderstandings and unnecessary complication. Since the train is a mass that makes up part of the surface of the earth I think we could reasonably say that the coordinate system for the entire earth is more general than that of the train, so it should be acceptable for both observers to use the coordinate system associated with the earth or the ground, which is the coordinate system that the observer on the footpath next to the track is using. Both observers will thus consider the train to be moving based upon the coordinate system associated with the earth. As I have argued repeatedly already, I do not believe that the observer on the train is justified in considering himself to be at rest. It would be completely unreasonable of him to suppose that it is the trees next to the track that are moving instead of the train. Come on, get real. He can feel the wind and the subtle movements of the train, and he remembers when it accelerated even if it is not doing that now, he knows that he and the train are moving!

To help make this discussion easier to follow, let's assume that the train is moving east to west. For the observer standing on the footpath this corresponds to the x coordinate. Directly in front of her will be considered the z coordinate, and up and down will be considered the y coordinate. This means that the observer on the train is looking backwards and is thus looking east while the observer on the footpath is oriented so that she is facing north.

The observer on the train should not say that it is false that the rock moves in a parabolic path, even from his perspective. Rather, he should say that he does not know whether it does, at most. He can see that it moves downward in the y coordinate. He may not be able to tell for sure from his vantage point whether it moves along the x coordinate or not, but he could not rule it out as a possibility either. In fact, that is by far the most likely possibility.

Galileo learned that projectile motion is best treated as a combination of horizontal motion and acceleration due to gravity which causes the projectile to have a curved path down to the ground (the curve is part of an upside down parabola); if the observer is familiar with this work, and also just drawing upon a lifetime of observations and experiences in which he has seen objects fall in various circumstances, then he would likely assume that the stone has horizontal motion as well. He may not be able to observe that in this instance, but he would be justified in thinking that it is quite likely based upon other experiences. What he does directly observe does not conflict with the stone also moving east as well as down to the ground. A lack of information is different than a contradiction. Based upon what he has observed he could conclude that he knows it moved along the y coordinate and he does not know for sure whether it moved along the x coordinate, but it seems likely. That does not contradict the other observer's account. In fact, if the observer on the train is wise, he should be willing to trust the other observer's account more than his own because she is in a better position to observe the horizontal motion than he is. Einstein treats this like every observation is equally accurate, but we know from experience that some vantage points give us more information than others. Our senses do a reasonably good job of informing us about the physical world around us, but they are not able to perceive everything that happens. That is just the way it is.

But often we can piece it together pretty well based upon putting our observations into context with past experience and looking at multiple perspectives. That is the case here. In reality, the observer on the train can reasonably conclude that it is quite likely that the stone does fall with parabolic motion based upon trusting the account of the other observer and his general knowledge about how projectiles move. It would actually be quite unexpected if one released the stone and it went from moving at the same speed as the train to immediately stopping in mid-air (I mean the horizontal motion) and falling down in a straight line. Did Einstein really think that is what happens according to the coordinate system of the train? That is what the quote above indicates, but that is hard for me to believe. He definitely should not have believed that if he really did. Based upon only this one observation the observer may not be able to rule that possibility out, but when the observation is put into context with all of his other experiences and the collective experience that comes from other observers it would be very unlikely that the stone would not fall parabolically, and this observation does not actually conflict with that possibility it just does not confirm it. The observer would therefore be justified in saying that he knows that the stone moves in the y coordinate and he at least strongly suspects that it also moves in the x coordinate. This is actually far more reasonable based upon his collective experience than believing that it moved down in a straight line, especially if the other observer is able to confirm that it moved parabolically based upon her direct observation. The answer to Einstein's question is not context dependent, it is not relative to the reference frame, the stone really does move parabolically for both observers and reference frames whether the observer on the train can perceive that motion in the x direction or not.

I have assumed throughout this discussion that Einstein is correct that the observer on the train would see the rock fall in a straight line, as he claimed, and would see no difference between this and if he had dropped the stone while the train was stationary. But actually that is quite unlikely. For one thing, if the ground is hard, and depending upon the speed, the stone could bounce and roll along the ground in a much different way if it has horizontal motion than it would if it does not. That is no small difference. We learn through a wealth of life experience to notice subtle differences like that. In real life the observer would quite likely be able to tell that the stone was moving horizontally even from his vantage point. It is actually pretty far-fetched to think that he couldn't and that he would really believe that the stone fell to the ground in a straight line, or that falling to the ground in a straight line would be the 'truth' relative to the train's coordinate system. There is only one truth. The stone falls parabolically just like any other projectile on earth that has horizontal motion, and the observer knows when he releases it that it has horizontal motion that comes from the train. This would be a fact in all reference frames and for all observers whether those observers are able to perceive it or not.

Let's assume that we have two spaceships exactly 299,792,458 meters apart. At a predetermined time and according to a prearranged plan each ship transmits a light signal that lasts for exactly one second. If observers on each ship see the other ship's signal exactly one second after their own ship began transmitting their signal and simultaneous to when their signal stops would that not be enough to say that they must have both begun transmitting the signals simultaneously? It is true that it was not directly observed to be simultaneous by viewers on either ship, the viewers are required to make a deduction from the relevant facts, but since they know the exact distance and they know the speed of light they could easily infer with a great deal of certainty that in fact the two signals began transmitting at exactly the same time. For me that is enough to say with confidence that the two events were in fact simultaneous.

Now suppose that we have a huge platform in outer space which is exactly 299,792,458 meters long. One observer is standing at the midpoint. At each end of the platform two pulsing light sources are set to flash a signal every three seconds and the pulse lasts for half a second. The observer has a mirror so that she can turn towards one and still see the other with the mirror. As one would expect, she observes the two flashes to begin and end at the exact same time, just as they were programmed to do, and she considers them to be simultaneous.

Now let's say that there is another observer 10 meters away who is directly in front of the observer that is standing on the platform and is facing her. We will say that this observer is inside a small spacecraft. Suppose that we now move the platform 5,000,000 meters to the right according to the second observer. This would, of course, make a difference in how the signals are perceived by the observer in the spacecraft. He would no longer perceive the light flashes to be occurring simultaneously because one of them is now closer to him. So would we say that the light flashes are no longer simultaneous for him? I guess in a way that is accurate because that is what he would observe, but there should also be, and often is, a recognition that there is a more fundamental truth, and that is that in fact the two lights are actually flashing simultaneously in his frame of reference just like all the others, he just does not perceive it that way because he is closer to one of them.

While this observer could not directly perceive the two light flashes to be occurring simultaneously anymore, he could use other pieces of evidence to deduce that this must be the case. First of all, he could rely on the testimony of the observer still at the midpoint of the platform. He could simply ask her whether she still sees them as being simultaneous. He knows that the lights have been programmed to flash at the same time and there is no reason to think that this has changed since the platform was moved, particularly if the observer on the platform confirms that she still sees them to be occurring simultaneously. In this case he should trust her perception of the events over his own because she has a vantage point that is likely to provide more accurate perceptions. But if he still had doubts and wanted to double check he could also calculate when he should see each light signal, if they were occurring simultaneously, based upon his distance from each light, and then he could verify whether his observations match the calculation. If they do, and if he can remember that he himself perceived them to be simultaneous before the platform was moved, and based upon the other observer's testimony of her observations, then it seems to me that he knows with as much certainty as anybody can know anything that those two light signals must be flashing simultaneously even if he cannot observe that directly.

I think it is the same with a reference frame that is in rapid motion. Suppose there were two such platforms that are identical except that we have an observer standing in the middle of one of them. When they are parallel to one another and both are at rest, with both observers directly facing each other (one is still in the small spacecraft) all four lights are judged by both observers to be flashing simultaneously. If we imagine the platform with the observer rushing past the other at half the speed of light and now the two observers disagree over the timing of the flashes I don't know that we should conclude that the flashes are no longer simultaneous. Most likely they are still simultaneous, it is just a difference in perception because of the extreme disparity in their speed. Relativity asserts that there are multiple truths and that observers in each reference frame always accurately perceive what is the truth for their reference frame. But an observer's perceptions can be inaccurate, or distorted, or maybe just not put into the proper context. Wouldn't that actually be the simplest and most reasonable explanation? An extraordinary claim is being made here, and I do not think that it is really warranted. It may be true that both observations are equally accurate in recording what it looks like from that point of view, but it is not necessarily the case that what it looks like from a certain point of view is an accurate description of how things really are.

In chapter 9 of *Relativity The Special and General Theory*, called 'The Relativity of Simultaneity', Einstein imagines that we have a long train moving at a constant velocity. In the prior chapter he talked about defining simultaneity by imagining that lightning strikes the train tracks in two places that are far away from each other with an observer directly in between, standing near the tracks on the embankment. We can say that the two lightning strikes are simultaneous if the observer (with the aid of a mirror) sees both flashes at the same time. But in chapter 9 he imagines that there is an observer on the moving train as well as on the embankment and he argues that the two lightning strikes are not simultaneous for the observer on the train because the train would be moving towards one lightning strike and away from the other. We assume that both the observers are at the midpoint between where the lightning strikes occur right at the moment when the strikes occur, but since the train is moving and it takes a little bit of time for the light to reach the observers the observer on the train will not be at the midpoint when the light reaches him. The observer on the train will thus see the lightning flash that he is moving towards before the one that he is moving away from and he will judge them to not be simultaneous.[17] Einstein then concludes from this:

> Events which are simultaneous with reference to the embankment are not simultaneous with respect to the train, and vice versa (relativity of simultaneity). Every reference-body (coordinate system) has its own particular time . . .

Whoa, hang on there. I don't think so. I can agree that it does not seem simultaneous to the observer on the train because of the observer's motion, but I do not agree that they are no longer simultaneous in actual fact. We already know the speed of light, so if you know the distance between the two lightning strikes and you know the speed of the train it seems like a pretty simple task for a competent physicist to figure out how much earlier the observer should see the flash that he is moving towards than the one that he is moving away from if they were in fact simultaneous events. If what is actually observed matches this prediction then what is the justification to say the lightning strikes were not simultaneous for this observer? Especially if the observer standing on the embankment at the known midpoint does directly observe them to be simultaneous. That should be considered corroborating evidence. Reference frames are not

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[17] John Norton in the chapter titled 'The Relativity of Simultaneity' from *Einstein for Everyone* explains it using an example that is pretty much exactly opposite of what Einstein says here. According to the example we have a long platform with an observer at the midpoint and two light sources at each end. Norton says that when the platform is moving the light from the light source at the back of the platform has to catch up to the moving observer. The signal from the front of the platform has a shorter distance to traverse to reach the observer, who is moving toward it. Norton reasons based upon the Light Postulate that both light signals must reach the observer at the same time because the observer is at the midpoint. While the observer on the platform will say that the signals occur simultaneously whether or not it is moving an observer in a different reference frame must say that the light signal at the back of the platform occurred before the other signal, according to Norton, so that it has time to catch up to the moving observer and reach the observer at the same instant as the other signal. Thus they are not simultaneous for this observer. I understand Norton's thinking to some extent, based upon the Principle of Relativity and the Light Postulate, but this is exactly opposite from what Einstein says in this example for the observer on the train. I believe Einstein would say about this example something similar to what he said about the observer on the train, which is that the observer standing on the platform would not see the two signals as being simultaneous he would perceive the light signal at the front of the platform to occur first because he is moving in that direction and away from the other signal. Once the light has been emitted it expands from that point in space at the speed of light independently of how fast the light source is moving. The observer is an equal distance away from the two light sources, it is true, but in the short amount of time that it takes the light from each signal to reach him he moves toward one light signal and away from the other. (We must distinguish between the light sources and where the light flashes occurred; the observer is an equal distance away from the light sources, not an equal distance away from the light flashes when the light reaches him.) He will thus see the signal or flash that he is moving towards as occurring slightly before the other one. If the observer in a different reference frame ever sees the other signal (the one at the back of the platform) to have occurred first it would only be if he happened to be closer to that one as the platform went by. I think Norton is mistaken on this, both factually and in how he represents Einstein's view. One interesting thing about the example though is that the same observer, the one on the platform, would see the signals go from being simultaneous when the platform is at rest to perceiving them as not simultaneous when it is in motion. The observer should realize that it is not the actual simultaneity of the events that has changed, it is only his perception of them that has changed. That implies it would be the same for judging simultaneity in other reference frames as well.

entirely independent of each other, they are interconnected. If they were not interconnected there would be total chaos. Nothing would make sense when moving from one reference frame to another. The observer on the train simply needs to do the math. The lightning flashes are simultaneous for him just as much as they are for the observer standing on the embankment.

The fact that some observers do not perceive events to be simultaneous does not necessarily mean that the actual simultaneity of the events is relative. I would say that whether they are simultaneous or not is an objective fact that is independent of how, or when, or even whether those events are perceived at all by any observer. There is an independent reality that is separate from an observer's perception of it.

I believe it is an objective fact that the earth revolves around the sun, but Relativity asserts that all observations from every reference frame are equally correct, so if you really believe that you would have to say that if it looks like the sun is moving around the earth to an observer on earth (and often it does, which is why so many people have believed that historically) then for that frame of reference it really does.[18] Is whether the sun moves around the earth or the earth moves around the sun relative to the reference frame? No. Despite how it may appear to observers on earth at times, it is an objective fact for all reference frames that the earth really does revolve around the sun. If someone perceives it the other way then that perception is simply not accurate in describing things as they really are.

$E = mc^2$

Along with the claim that nothing can exceed the speed of light, $E = mc^2$ is probably the most well-known part of the Theory of Relativity. We even learned a little bit about it in my seventh grade science class. This is no doubt the most famous equation in the world today. Somewhat ironically, however, even though this is one of the things that Einstein is best known for, this actual equation did not appear in his own writings. He expressed his view of the relationship between matter and energy differently, although how he expressed it is somewhat equivalent to this, simply requiring a rearrangement of the terms with a few substitutions.[19] It is said to reveal one of the great fundamental truths of the universe, which is that matter and energy are actually the same thing. It is a simple and elegant equation. Unfortunately, I don't think that it is true.

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[18] This is another similarity that the Theory of Relativity has with Moral Relativism: the observer cannot be wrong for his reference frame, just as in Cultural Relativism a cultural practice or belief cannot be considered morally wrong for that culture even if it is thought to be morally wrong by other cultures.

[19] This was also something that Poincaré talked about before Einstein did. It seems like Einstein was really influenced by Poincaré's work, but to my knowledge he never fully acknowledged that. Einstein did have his own derivations for the connection of mass to energy, but he should have mentioned Poincaré if that was what had initially inspired him.

Even after I began having serious doubts about other aspects of Einstein's theory I thought that this might still be correct - I wasn't too sure about the c^2 part, but it seemed like it could be true that matter and energy are the same thing. Sometimes we think of matter as stored energy. When your body stores fat, for example, that is sometimes thought of as stored energy. There is also said to be a tremendous amount of stored energy in fossil fuels. The idea seemed intuitively plausible. It also seemed reasonable to think that perhaps at the most fundamental level there is really one kind of thing.

However, upon further reflection, I now believe that it is not the case that matter and energy are equivalent. Einstein had a tendency to try to unite everything but in this case they are not the same type of thing at all.

There is not really a great definition of what we mean by the term 'energy', even though most of us have a vague sense of the idea, but one thing that I feel sure about is that it is not a substance. To say that matter and energy are different forms of the same thing treats energy as though it is a very light, very spread out fluid, like a much much less dense type of gas that leaks out (in the form of radiation) or is absorbed by matter, and matter is simply a really dense form of it. A fluid is of course a type of matter, but energy would be similar in that it would have to be the same underlying substance or 'stuff' as matter if they are equivalent.

It is hard for me to define exactly what energy is as well, but I do not think of it as a material substance. If it was a substance then what is potential energy? Is it an actual 'thing', as in a fluid that is inside of objects like air inside of a balloon? I do not see it that way. 'Potential energy', by definition, cannot be actual; so how could it be an actual material substance within the object, and why wouldn't it just be considered more matter?

Gravitational potential energy is the energy that the object would have, if it were falling toward earth's center of mass, although it is not falling at that particular time. In other words it is only theoretical. Gravitational potential energy is not a substance that accumulates inside the object based upon its position relative to earth.

Kinetic energy also, such as when a ball is actually rolling down a decline plane, is not really a substance. Einstein thinks that an extremely small amount of that ball's mass is converted to energy as it rolls, but I just don't buy it. For one thing, the object would have to lose potential energy as it gains kinetic energy (and as it moves closer to the ground) because kinetic energy is a type of actual energy; but if it is losing potential energy it ought to be gaining matter because potential energy is a subset of energy. So is the ball gaining or losing matter? It seems like the answer is both, but that does not make sense.[20]

To me, both kinetic energy and potential energy are more like a force, or potential force in the latter case. A force is obviously not material. 'Energy' is our word for when unbalanced forces cause a change to matter, such as an acceleration. For example, one ball is put into motion by something else acting upon it; I actually do not think it would have kinetic energy if it was moving inertially through a vacuum because there would be no change to it or the surrounding environment (but it would have an equal amount of potential energy because of its momentum) but even if there is air its motion would be accelerated and it would be causing a change to the matter around it, so it would have energy in that case; now suppose that it comes to a near stop as it collides with another ball and now the other ball is moving; much of the energy of the first ball was transferred to the second one, while some of it would be transferred into other physical processes. (Objects would always retain at least a little bit of energy because there is always some motion of the particles within them.)

The motion of objects is the simplest case, but there are other types of energy, such as radiation and heat. These are still due to the motion of particles, however. Energy is related to motion. More broadly though, energy is any change to matter. Potential energy is a theoretical projection of the possible changes that would take place if a hypothetical scenario was actual. For example, gravity is continuously acting upon objects but sometimes they are not accelerated because other forces are also acting upon them which prevent that. There is recognition that if these latter forces were removed the object would be accelerated. Thus it has gravitational potential energy.

Even though energy is not a physical substance that flows from one object to another, I do think of it as being real because the effect on material objects is real. It is as real or actual as 'force'.

Events do not take place in a vacuum. An effect has a cause, and it in turn becomes the cause for some other effect, which causes something else, and so on, in a chain of events. When an object absorbs energy it simply means that the matter in the surrounding environment causes some change in the object. When there is a change within the object that change will spill out into the surrounding environment by disturbing the matter that is around the object and the object gives off energy. The general principle here is that a change in matter also affects the matter that is around it. I think this is why we have the feeling that energy is neither created nor destroyed. It is somewhat cyclical.

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[20] The claim that I made in the prior paragraph that potential energy is merely theoretical could be controversial. Some see it as stored energy and they might argue that the law of conservation of energy requires that it must be real because energy is never created or destroyed so potential energy is what is converted into kinetic energy and other forms of actual energy. Thus potential energy would have to be actual as well. (They would apparently see a difference between 'potential' and 'theoretical' or 'possible'.) If that is what you believe then the problem identified in this paragraph would be even more serious. But even if you view it as merely theoretical, as I do, that does not really resolve the problem either because would it be the case that the ball is gaining merely hypothetical mass while losing hypothetical potential energy?

When one ball hits another, which causes the first to slow down (decelerate) and the other to accelerate, we say that the first ball transferred a lot of its kinetic energy to the second. But there is no transference of matter between the two.[21] It is simply that the motion of one caused the motion of the other, which is all that is transferred.

Waves, such as water waves or seismic waves, travel through matter - in fact the wave is a disturbance of the matter. Energy is often transferred this way but it is not as though the wave has some sort of physical substance running through it known as 'energy' that is transferred from one object or medium to another. When we say that the energy travels with the wave that does not mean that energy is a physical substance. Waves do not have energy, waves are energy, or one form of energy. Energy is the disturbance, the motion itself.

When a mass emits radiation I don't think that this should be thought of as a fluid that is extremely condensed while in the form of matter and then this fluid leaks out and is spread out in the form of electromagnetic radiation. I also do not think that it is true that a mass is absorbing more of this fluid when it absorbs radiation either. As I will argue in later sections, radiation is a disturbance of the material that surrounds the object, just like any other wave. Just as a wave is not matter, but rather a disturbance of matter, so also energy is not matter, but movement and change within the matter.

Energy is not a tangible thing any more than momentum or force or power or work. It is actually a category mistake to think of energy that way. Energy is not a substance.

As nuclear reactors and nuclear bombs attest, splitting atoms apart in a chain reaction (especially an uncontrolled chain reaction) does release a tremendous amount of energy. Defenders of Relativity regard this as irrefutable evidence that the formula must be true, but I do not believe that $E = mc^2$ necessarily follows simply from the fact that a lot of energy is produced from these reactions. We do not know that matter is being transformed into energy in these reactions,[22] nor

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[21] There seems to be some ambiguity about how matter is related to mass in the theory. Is this supposed to refer to the so-called 'rest mass' or 'inertial mass'? One may be tempted to say inertial mass because of its connection to speed, and that does seem like it would be a more elegant connection. But I don't think the claim could be about inertial mass because that was not said to increase the matter, i.e. the number of atoms in an object. If matter is converted into energy and vice versa then that would have to be related to a change in the 'rest mass', with a very tiny bit of it converted into energy. In fact, an object in rapid motion, say something that is traveling at .75c would have actually lost a lot of mass as this is converted into kinetic energy by moving at such a high speed, yet its 'inertial mass' would be much greater than if it was at rest. How can it have less matter yet more mass?

[22] The law of baryon conservation asserts that neutrons and protons cannot be converted entirely into useful energy, but rather only into other neutrons or protons, or similar particles. This law locks up or makes unavailable for conversion into energy the vast majority of an object's mass. See Robert Geroch's commentary on section 15 (p. 199-200) in *Relativity The Special and General Theory.* It is acknowledged then that well over 99% of an object's mass is not converted into energy. I do not believe that electrons are either. (Nor bosons; I do not think those particles even exist.)

do we have, at least as far as I am aware, any real evidence for energy turning into matter. The reason that so much energy is released in a nuclear explosion is that it spreads exponentially and very fast to neighboring particles. The short amount of time that all of this takes place is why it is so disruptive to the surrounding environment. It is like an earthquake, which also creates a lot of energy. That does not mean, though, that matter is converted into energy in either case.

Energy is often created[23] or caused when bonds between molecules and atoms are broken. For example, molecular bonds are broken in a chemical reaction when fossil fuels are broken down into simpler molecules which creates energy that is converted into mechanical energy by the vehicle. The human body does this as well when it burns fat. But energy can also be created and released when bonds are created. For example, it seems to be the case that the sun is converting hydrogen into helium, which is a heavier element than hydrogen. That means that bonds are being formed. The particles are not splitting apart - that is not what is causing the energy - they are joining together. The reason that this also causes energy is that energy is simply a change in the matter. What happens inside the sun affects the surrounding environment, which is an example of energy being transferred and spread to other matter. If mass is simply really densely packed energy then as bonds between atoms are formed and it becomes even more densely packed that should suck up energy from the surrounding environment rather than give it off. Where else but the surrounding environment would the energy come from? It would not be a little bit of energy either; c^2 is such a huge number that it would require a massive amount of energy to form even a tiny bit of matter. The most energy would be required to actually form the particles, but if we are going to argue that splitting the atoms apart converts matter into energy then the reverse ought to hold as well: when bonds are formed that should vacuum up energy from the surrounding environment, which would be consistent with the notion that matter is simply a highly condensed form of energy. Thus nuclear fusion reactions would require an input of energy rather than give off energy. But of course that is not what is actually observed in nature.

SUMMATION FOR PART I

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 at which electromagnetic waves happen to move, or that since we perceive things using those electromagnetic waves our perception of the

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[23] I am using the term ‘created’ or ‘caused’ rather than ‘released’, as is more common, because ‘released’ makes it sound like it is stored up inside the matter and something caused it to be freed so that it can spread out, which of course is exactly what most people believe is happening. I mean created or caused in the sense that something happens which causes a change or disturbance of the matter that was not there (or at least not noticed) before, thus the energy seems to suddenly appear. But it was not generated from nothing. Something caused the change, which eventually also causes a change to the matter around it, thus the energy is transferred, sometimes in several different forms. Whenever it takes on a new form one could consider that a type of creation or generation, but not ultimate generation from nothing. I do not believe that has ever taken place at all.

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.

Maybe you think that Einstein has to be right, because, well, he's Einstein. But there was once a time when even Einstein wasn't EINSTEIN, the name that has become synonymous with genius, he was just a patent clerk who couldn't get a job in science. Think about it objectively, which explanation seems more reasonable?

I am not actually questioning the empirical data as much as I am questioning how that data has been interpreted. But I know that scientists want experimental evidence, so here is how it 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 for the other reference frame. If the spaceship giving the signals went by the stationary ship at .5c the signal ship would appear to 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 them; then, after it had passed them, 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 of 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 he or she 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.

Part II
The General Theory of Relativity

What we have been discussing so far refers to what has come to be known as the Special Theory of Relativity. This is Relativity without taking gravity into account. Some say that the Special Theory of Relativity is a theory about light and the General Theory of Relativity is a theory about gravity. But the Special Theory of Relativity is the foundation for General Relativity. If Special

Relativity is incorrect then it is quite likely that General Relativity is as well. It would be like a building with a faulty foundation. Most of my critique is aimed at Special Relativity, which in turn undermines General Relativity, but I would also like to address some things about General Relativity more directly.

THE PRINCIPLE OF EQUIVALENCE

The Special Theory of Relativity is connected to the General Theory through the Principle of Equivalence, which states that there is an equivalence between inertial and gravitational mass. Einstein has a famous thought experiment in which he imagines a very large chest (or we may imagine an elevator) in otherwise empty space that is continuously pulled upward by some force using a rope. This would give the sensation of gravity to a person inside the chest. In fact, Einstein thinks that this uniformly accelerated motion is indistinguishable from gravity. The person inside could just as easily consider the chest to be at rest, suspended by the rope in a gravitational field that pulls it down. According to Einstein this would not be wrong; that would actually be an equally correct way of describing what is happening.[24] Apologists point out that one strength of this account is that everything, regardless of size or weight, would 'fall' or be pulled to the floor of the chest at the same rate, which is also true of gravity, and that is considered to be an otherwise puzzling characteristic of gravity.

However, the fact that it would feel the same (or similar) to a person inside does not mean that it actually is the same. Even if it was the same effect (I am not convinced that it is) that does not mean that it has the same cause.

There is something else that bothers me. In the thought experiment the chest is not an inertial frame of reference, it is accelerating. Einstein (correctly) says at the beginning that if the chest is at rest in otherwise empty space the observer would not be experiencing gravitational effects of any kind. He says that the observer would have to fasten himself with strings to the floor to keep himself from bouncing around the chest (similar to what actually happens with an astronaut in free fall) because there is no gravity. But if the chest was moving at a steady velocity the exact same thing would happen: the person inside would be in a state of free fall because he would be moving just as fast as the chest. An inertially moving frame, no matter what speed, would feel the same to an observer within that frame as if the frame was at rest. Special Relativity is 100% committed to that; in fact, it says that the observer wouldn't even be able to tell that he or the reference frame were moving. If the chest was moving at a constant velocity the observer would

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[24] He says in chapter 20 of *Relativity The Special and General Theory*:

> Ought we to smile at the man and say that he errs in his conclusion? I do not believe that we ought if we wish to remain consistent; we must rather admit that his mode of grasping the situation violates neither reason nor known mechanical laws. Even though it is being accelerated with respect to the "Galilean space" first considered, we can nevertheless regard the chest as being at rest.

be moving at the same velocity and would continue at that same velocity until some force acted upon him to change it. If the chest is moving at the same speed it would not be the chest that acted upon him, and there is nothing else around. Moving at a steady speed would not create even the sensation of gravity for the observer. Einstein must have known that, which is why he said that the elevator was being accelerated. But he is inconsistent about whether it is acceleration that is equivalent to gravity or whether it is moving at a high speed relative to light. If the frame is accelerated upward it would indeed feel to the observer like gravity is pulling him toward the floor of the chest, but suppose that it is instead moving at steady velocity that is really high relative to light, what happens then? According to Special Relativity, if the chest was moving at a steady speed of .95c in the upward direction its inertial mass, and thus its 'gravitational force' would be very high even though it is not accelerating because inertial mass increases as the speed gets closer to the speed of light. But if the inertial mass of the chest and the observer are higher because of moving at .95c, as Special Relativity asserts, the observer would not be able to feel that or detect it in any way. So what does inertial mass have to do with gravity? Obviously observers can detect an increase or decrease in the gravitational force, they will feel it and observe other differences within the frame, which means that an increase or decrease in inertial mass is not equivalent to an increase or decrease in the gravitational force, even supposing that there is such a thing as 'inertial mass'. If the chest was moving at .99c but at a steady velocity the observer would be in free fall, just as he was when the chest was at rest, even though it and the observer's inertial mass would be much higher than when the chest was at rest. This thought experiment does nothing to prove the equivalence of gravitational and inertial mass; at best it could only be used to prove the equivalence of gravitational effects and acceleration.

In a related point, for Special Relativity time dilation is a function of speed: the closer that you get to the speed of light the more that time slows down for your reference frame, although an observer in that reference frame would be unaware of this. In General Relativity stronger gravitational fields also cause time dilation. But we have a similar problem. In Special Relativity time dilation would occur even if the reference frame was moving inertially because time dilation is caused simply by moving at speeds close to the speed of light; but moving inertially would not be equivalent to, or even feel like gravity at all.[25] Thus, an inertially moving reference frame (even at a speed close to the speed of light) is not equivalent to a gravitational field even if an accelerating frame was. So why then would time dilation occur in stronger gravitational fields? Or, if it does occur in stronger gravitational fields, why would a reference frame that is moving inertially at .95c still experience time dilation? There should only be time dilation when and if the frame is accelerating if acceleration is equivalent to gravity. These are major inconsistencies in the theory that apparently others either do not notice or just choose to ignore.

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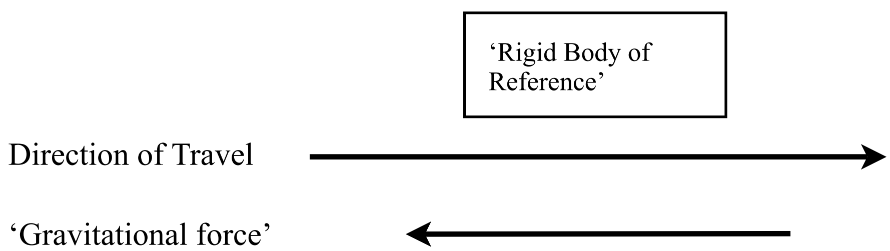
[25] If you were on the bridge of a starship that accelerated laterally you would feel the acceleration as you were pushed back into your seat, similar to how it feels when an airplane takes off. This is supposed to be equivalent to gravity. But as every airline traveler knows, once the plane reaches a cruising altitude and a fairly steady speed you hardly feel any force at all unless the plane runs into turbulence.

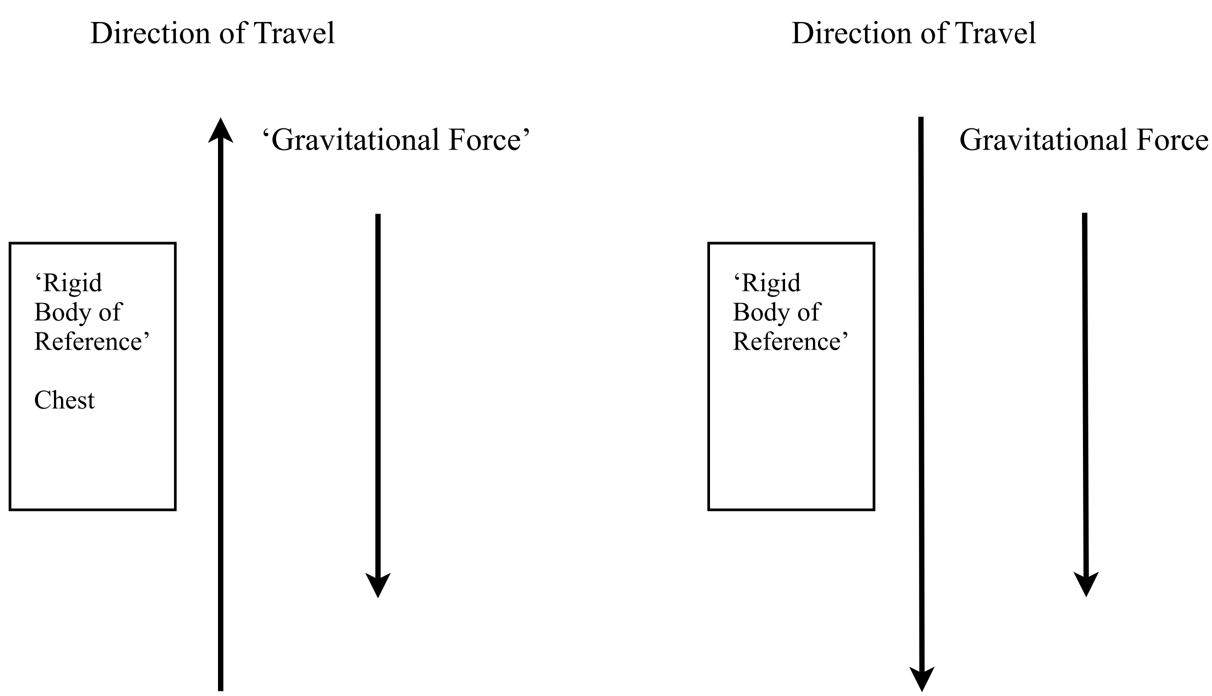
What Einstein described in the thought experiment has come to be known as g-forces, which stands for gravitational force equivalent. It is named that because scientists adopted Einstein's view that acceleration is equivalent to gravity. (Or is it 'inertial mass' that is equivalent to gravity? I don't honestly know which it is, but they are not the same.) I admit that acceleration does feel somewhat like gravity, probably because gravity causes bodies to accelerate, so accelerations that occur because of other causes feel similar to an observer. But I think there are some clear differences.

The main difference would be the direction of the force. See the following diagrams:

Special Relativity: Body in Rapid Motion



In this first diagram we have a rapidly moving reference frame. According to Special Relativity the reference frame and everything in it are contracted in the direction of motion and the inertial mass increases because of the speed. An observer would not be able to detect this, but if the frame was accelerating the observer would feel that. The force (only if the frame is accelerating) would be in the opposite direction of the direction of travel.



In the second diagram we have the upwardly accelerating chest that Einstein spoke of in the thought experiment earlier. Everything is the same as the first diagram except that the direction is vertical rather than horizontal.

One will notice that in the third diagram there is a difference: the direction of travel and the gravitational force are pointing in the same direction. If we have a body that is being pulled or attracted to the earth's center of mass, say when you have a space shuttle reentering earth's atmosphere, it is being pulled in the same direction as the direction of travel. In fact, the movement of the reference frame is due to the pull of gravity.

In the prior examples the so-called 'gravitational force' was in the opposite direction to the direction of travel as a result of being accelerated by some other cause, say the ship's thrusters. In other words, it is a reaction to the ship's motion not the cause of the motion. When one is sitting in an airplane at takeoff and it pushes you back in your seat, that is the reference frame (the airplane) accelerating you up to its speed. The plane is being pushed forward at a faster rate than you are moving (your body would have inertial motion if nothing acted upon it) by its engines, and it transfers this acceleration to you, causing you to accelerate also. But if you were in the space shuttle that was reentering earth's atmosphere your body would be accelerated towards the earth at approximately the same rate as the shuttle is being accelerated, so you would not feel that intense force pushing you back into your seat. In the case of gravity your body is attracted to the earth rather than being pushed from behind by the shuttle.[26]

Another way of making this same point would be to imagine a spaceship moving around a large circle. This would create g-forces because the ship has to change direction slightly to keep moving in a circle. This acceleration may feel somewhat like gravity, especially if the ship dipped down a little on one side (towards the center of the circle), which it would do because that would be more comfortable for the crew, as the centrifugal force would then push them against the floor of the ship rather than off to one side. Supposedly this is exactly equivalent to gravity. There would be no difference between having the ship's navigation system and engines keep it moving in a circle and orbiting a large mass, such as a planet, that was causing the ship to change direction because of distorted space-time or gravity. But note the direction of the force. In this case the g-force is a result of the fact that the passenger's body would continue to move in a straight line because of the law of inertia but the ship acts upon it to change the direction of her motion so that she moves towards the center of the circle. This presses her against the floor of the ship as the ship accelerates her and gives her circular motion. The g-force is directed outward, away from the center of the circle. Gravity, on the other hand, is a centripetal force for orbiting

[26] As a side note, one thing that I wonder about here is length contraction. In the case of horizontal motion the body is supposed to be contracted in the direction of motion. In the case of the chest one would assume that it would be contracted in the vertical direction as its speed approaches the speed of light. Would a high gravitational field cause length contraction? Einstein never said that it does, so far as I am aware, but to be consistent one would assume that it would if it causes time dilation. So suppose that it does. But why would the length be contracted when it is being pulled towards a mass? It seems like, if anything, it should be elongated and stretched out in the direction of motion rather than compressed.

bodies: it pulls them in toward the large mass. Like Newton, I believe that gravity is an attractive force between masses. Although g-forces may feel similar to gravity in some cases they do not have the same cause.[27]

Suppose that earth's gravity suddenly became one thousand times stronger. According to the Principle of Relativity this would only be noticeable from other reference frames. One would have to say this because according to Special Relativity time dilation would be relative if it is caused by moving at a high speed, because speed is relative, and if the Principle of Equivalence holds then it would have to be the same way if the time dilation was due to a stronger gravitational field. All physical laws would be perceived to remain the same within the reference frame, including how fast time passes, so observers would not be able to tell if the gravity of their frame increased. In Special Relativity observers cannot perceive the increase in inertial mass for them and their frame if they are moving at .95c versus moving at .15c. If an observer is unaware of increases and decreases in inertial mass, and inertial mass is equal to gravitational mass, then it follows that an observer would not be aware of an increase or decrease in the gravitational mass or the gravitational field. Therefore I think that the Theory of Relativity is committed to this, but it would be totally nuts to make that claim.

If earth's gravity was measured to be that much stronger from the perspective of other reference frames then observers in those frames would also have to be able to observe the fact that no human on earth could even stand up; in fact, most if not all living things would be dead. It is not all relative. There would be noticeable corollary effects of the change in gravity besides the measurement of the gravitational force. Unless we want to say that observers in other frames see people on earth as being dead while from the perspective of earth they are going about their business as usual, blissfully unaware that anything has changed, but that would seem to be taking the Principle of Relativity to absurdity.

What would an observer on earth see for other reference frames? (Assuming that there was an observer that was not dead.) Wouldn't the observer have to perceive gravity to decrease by a proportional amount for other reference frames if he perceives gravity in his own frame to still be the same? Or would it be that the observer would perceive other frames to have stronger gravity while his remains normal, similar to how two observers could both see length contraction occurring for the other frame but not their own? But if every other reference frame that the observers on earth measured seemed to have its gravitational field decrease by a consistent amount (or increase, it is unclear which) that should be an indicator to them that it is probably their frame that is experiencing the change rather than all of the others. (The same would be true for a rapidly moving reference frame too.)

Would Mars be affected by earth's gravity becoming one thousand times stronger? Surely so, as would the moon and everything else in the solar system. If these are some of the other reference

[27] Another famous thought experiment that Einstein came up with was the rotating disk. He thought this would create gravity. It would cause g-forces but not gravity.

frames that we are talking about then obviously it would affect observers there as well. Einstein treats each reference frame as though it is entirely separate and independent from all others but that is not the case. They are all part of a larger interconnected system. What happens in one frame often affects those that are around it. The Principle of Relativity does not account for that fact. It may appear to be somewhat plausible for motion (though I do not think that it really is) but it is not at all plausible for gravitation.

Finally, let's go back to inertial mass and its purported connection to gravity. If a body in motion at a speed near the speed of light has higher inertial mass, and this is equivalent to higher gravitational mass or a stronger gravitational field, then that body should not just be more difficult to accelerate, which is what Relativity focuses on, it should also more strongly attract other masses. Other objects would be drawn to it just as they would be to a very massive body such as a large star. In the language of Relativity this would be because a body moving at .99c would create an extreme distortion of space-time just as a large massive body does. The space-time distortion is why time would move slower. An object that is moving right at the speed of light would supposedly be infinitely massive just as a black hole is said to be.[28] But if that is true then obviously a very fast moving reference frame such as this would dramatically affect all the other reference frames in its vicinity; their space and time would also be distorted and they would be attracted to it almost as strongly as they would be to a black hole. An object moving that fast would be a traveling black hole, or nearly so. As its length is contracted its mass is squeezed into a smaller and smaller volume, making it more dense. Something as large as a spaceship traveling at .99c, if it went right by the moon, would vacuum up the moon, and probably the earth as well. Obviously after the ship slowed down there would still be measurable effects that would be permanent even if the length contraction was not. The solar system would be permanently altered by something like that from the perspective of all reference frames.

The spaceship would not move in a straight line either. It would be attracted to, and thus be deflected towards other very massive objects as well, just as other masses are attracted to it.

Now I ask: Do you really believe that the gravitational attraction of the ship increases with its speed and purported increase in inertial mass?

SPACE-TIME

Another thing that Einstein is known for is the concept of four dimensional space-time, but actually he got the idea from Hermann Minkowski, who was one of his teachers. (He did give credit to Minkowski, although he sort of had to in that case, because everybody knew where he had gotten that idea.)

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[28] Another similarity is that length contraction would mean that is has zero length, similar to how a black hole is said to be a point with no extension.

Einstein seems to have been attracted to the idea because he thought that motion and gravity affected both time and space, so we could join them together with time being the fourth dimension. I do not think that is really true, so I am not inclined to join them together. Space and time are two fundamentally different things. I guess one could use time as a fourth coordinate for plane geometry (as in: x, y, z, t) if this is needed to fully describe an event, but time is much different than a spatial dimension and I feel like joining them together as 'space-time' tends to muddy the waters so that time is erroneously treated as another spatial dimension.

I have a more Aristotelian view of time. I think of time as motion or change.[29] If everything everywhere stopped changing there would be no more time. Sometimes we even refer to it as being 'frozen in time' which means that all motion has stopped. Most of the ways that we have of measuring time are related to motion. One year is the earth moving around the sun one time, a month is based upon lunar cycles, night and day are related to the sun coming up and going down, etc. Even clocks and watches of a certain kind are based upon the motion of the hands pointing to the correct number. This is the main reason that I am skeptical of being able to go back in time: time is change, not a spatial location that one can travel to. Unless you could somehow reverse all processes and then set them moving forward again from that point there is no way to return to a previous moment in time. Even if everything else remained the same, just the process of going back in time and the very presence of the traveler would be a change from how things originally were, which means it would not be the exact same timeline as the original, it would only be similar. Everything in the whole system would have to be reset to how it was previously in order to really be back in that time, and new variables could not be introduced. That does not seem possible. Time seems to only move in one direction because things are always changing; even if we change them back to how they once were that moves time forward because that is also a change. This is why time is not at all like a spatial location or coordinate, and should not really be described that way.

WHAT IS SPACE-TIME?

Relativity uses 'space-time' coordinates frequently but it is unclear what the term is actually supposed to refer to. Is space-time a material substance like air or water, or is it just a hypothetical set of coordinates? It seems clear that Einstein did not think of space-time as a physical substance because he talked about light moving through a vacuum. But a vacuum is defined as a space that is entirely devoid of matter. If gravitational effects are due to the distortion of space-time then space-time has to be a physical 'thing' of some kind; if it was a vacuum there would be nothing there to distort.

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[29] Attentive readers may notice a similarity here with what I said about energy. Time and energy are not the same thing, but I do think that they are related. Energy is a change to matter. Time is a scale composed of regular intervals or units, such as a second, that is used to measure and quantify change. Spatial coordinates can be used to measure material objects and time can be used to measure changes in energy.

People sometimes refer to the ‘fabric of space-time’; I know it is just supposed to be an analogy, but note that fabric is a physical substance, not just a set of coordinates. It makes one wonder what space-time’s physical characteristics would be. Is it a solid, liquid, gas, or plasma? If none of these, then what? It would have to be something.

Here is another significant issue: which is the cause and which is the effect? Does gravity cause space-time to be curved, or does curved space-time cause gravitational effects? If it is the latter, which is usually the explanation given, then what causes space-time to be curved? (Don’t say massive objects, because that would just be another way of saying gravity, which makes the whole thing circular: you would be arguing that gravity causes curved space-time and curved space-time causes gravity or is gravity.) The reason that this is important is because it is possible that the gravitational force could cause both the warping of space-time and an attraction between objects. But in that case the warping of space-time would just be another effect of gravity not the cause of gravity, and we still would not have really explained gravity. But if curved space-time is what we experience as gravity then we still have not answered the question of what causes it to become bent and warped.

It seems like space-time is still being thought of as some sort of material that is being stretched and pulled and distorted. It would be strange to say that ‘time’ and ‘space’ are material objects, but I just don’t see any other way that ‘space-time’ could be acting upon masses like the sun and moon.

Sometimes in order to help people visualize the warping of space-time scientists use the analogy of a heavy ball, such as a bowling ball, resting on a trampoline (or a cloth sheet). Imagine that one flicked a marble across the trampoline; its path is going to curve towards the bowling ball. One can imagine that under idealized conditions perhaps that marble would have just the right amount of speed to orbit around the bowling ball for a revolution or two before friction slowed it down so much that it ‘fell’ towards the bowling ball until it rested against it. In that way it seems like a pretty good analogy to a planet orbiting the sun. However, it is only a crude analogy. First of all, the trampoline would only represent warped space, the time element is entirely eliminated. Also, unlike the trampoline (or a sheet), in which the ball rests on top of it and pushes it down (ironically, due to gravity) space-time would actually have to be distorted the most at the object’s center of mass rather than out at the sphere’s circumference. So space-time would have to be material, yet it somehow goes inside of other materials, and is distorted, but does not seem to distort the mass itself, even though that is where it is the most warped. It is hard to visualize what that would look like in three spatial dimensions.

If it was only geometry that caused gravitational effects then it would not matter what type of material the object was made of. Hypothetically speaking, if there was a planet composed of helium that had the same volume as a planet composed of iron they ought to displace and distort space-time by the same amount. Maybe the rejoinder to this would be that perhaps the reason that the planet made of iron is more dense is because the space-time distortion was greater to begin with, which caused the material that fell into it to become more densely packed. But are we really prepared to argue that the space-time distortion drives chemistry, turning one element into another? And once again, what causes the space-time distortion to begin with?

The space-time coordinate system is sometimes referred to as the ‘arena’ for events. Each event has three spatial coordinates and a time coordinate associated with it which would usually result in a curve as it moves through the time dimension and perhaps also through the spatial dimensions. I think it is ironic that General Relativity uses this system because it seems to contradict Special Relativity. The implication of having a coordinate system is that there is a set of space-time coordinates associated with an event that does not vary from observer to observer. If it did vary then there would have to be offset coordinate systems for each and every observer, and the whole thing would be pointless. It would be like having latitude and longitude lines and time zones that differ for each person yet all of them would be considered correct for that person. Why would you even bother giving someone else the coordinates of an event as you perceive it if that was really the case? If Special Relativity was correct the ‘events’ would not have identical curves for any two observers; at least one of the coordinates would be different, especially for observers in different reference frames. Could we even say that it is the same event in that case? If the slope of a line was different for two observers using coordinate geometry (two dimensional x, y, coordinates) but at the same time we say that both observers are correct in determining the slope of that line, as they see it, can we really say that it is the same line that they see? How could it be?

It may be acceptable to use a coordinate system like this for mathematical description but I think the arena would have to be considered a reference frame. This could in fact be the coordinate system associated with the entire universe, that, as I mentioned on pages 37 and 38, could be thought of as the reference frame that is equivalent to Newton’s absolute time and absolute space for every observer within it. Inside an airplane or a car the coordinate system associated with that body of reference could be considered absolute for all events that take place inside it, regardless of what takes place outside of it, because the reference frame itself is considered to be at rest.

NEWTON’S THEORY OF GRAVITY

I would now like to talk a bit about why Einstein was motivated to come up with his theory of gravity. Recall that in Special Relativity Einstein argued that nothing could reach or exceed the speed of light. Well, later on he began wondering about the gravitational force. If the sun’s gravity suddenly did not exist for some reason this would have a nearly instantaneous effect on the earth, which would immediately begin to fly off in a straight line in accordance with the law of inertia, while it would take a little less than eight and a half minutes for light from the sun to reach us. This bothered Einstein because nothing is supposed to be faster than light. At first he tried to modify his theory to say that the gravitational force moves more slowly than light, but that just didn’t seem to fit the facts. So this is what eventually led him to the idea that gravity must be caused by the geometry of space-time. If it was a distortion or warping of space-time then gravity could have an instantaneous or near instantaneous effect even when the bodies were great distances apart and it would not be the case that anything was moving faster than light. It would be like having the object slide or fall down an incline plane that is the distortion of space-time. (Once again this seems to assume that 'space-time' is somehow material; the body would not slide down a geometric plane of nothing.)

I don't think that Einstein's theory of gravity is correct. In fact, even the supposed problem is not really an accurate interpretation. It is true that the gravitational force is continuously acting upon matter, but I do not think of this as evidence that it moves faster than light. Gravity is not a wave, despite the fact that scientists have won Nobel Prizes for work on 'gravitational waves'. (More on this later; 'gravitational waves' are actually a different concept.) If it was a wave it would have to be millions of times faster than light, so much faster that effects even at incredible distances would be nearly instantaneous. I agree with Einstein that that wouldn't make sense, but it does not mean that it has to be a warping of space-time either.

Gravity is an attractive force between bodies of matter. It continuously acts no matter how far away the masses are from each other. The force gets much weaker with distance but it never entirely goes away. If one mass was altered or removed it would have a near instantaneous effect on other masses even if they were really far away from it.

This idea - that gravity is an attractive force between masses - actually comes from Isaac Newton. His law of universal gravitation states that every particle attracts every other particle in the universe with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centers.

I think Newton's theory of gravity makes a lot of sense, at least for the most part, but it took a little while for it to become widely accepted.[30] One reason is that Newton didn't know the underlying cause, the 'why', all that he could say is that there must be an attractive force between masses, based upon his calculations, even if he did not know exactly what it was. Like Galileo, he preferred mathematical description to deeper philosophical speculation about underlying causes,[31] but that could be frustrating for those who wanted a deeper explanation.

One cannot totally blame people for being a little skeptical of it at first. The idea seems pretty natural to most of us today, because we have grown up with it, but if you had been taught

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[30] It was accepted more quickly among natural philosophers who already believed Galileo's arguments. In fact, others in the intellectual community had similar ideas to Newton and he was in communication with them. Newton's greatness was not so much in coming up with a lot of original ideas, but rather in providing rigorous mathematical proofs and demonstrations for the ideas of the scientific community that he was part of, and he also drew inspiration from the work of earlier geniuses from times past. I am referring to the fact that it took a little while for others to accept it, such as the Aristotelian scholastics.

[31] He did finally speculate a little because of incessant prodding, but not very effectively in my opinion. For the most part he seemed fine with just accepting that gravity is a physical reality and if we can describe its effect mathematically, that is enough. Perhaps that is all that you can do if you don't really know what the underlying cause is. It is good that he focused on that because that is what he was good at.

Aristotle's idea of gravity as gospel your entire life, Newton's claim would have seemed bizarre. The gravitational force is much weaker than, say, magnetism; it certainly does not seem like two small objects, such as two books, are attracted to each other. (However it was later demonstrated that small objects do attract one another with the experiment of Henry Cavendish in 1798, who actually gave a fairly accurate calculation of the gravitational constant based upon the experiment.)

But Newton was a brilliant mathematician (he and Gottfried Leibniz seem to have each independently developed calculus) and he was able to very accurately describe mathematically the effect that gravity has on objects. He tied together and built upon the work of Galileo Galilei, who had focused on terrestrial motions near the surface of the earth, and Johannes Kepler, who focused on astronomy and understanding celestial orbits in particular. In doing so Newton could explain everything from solar eclipses to the ocean tides to why some objects fall to the earth and why others rotate around it, and all in one internally consistent and complete description and explanation of the phenomena. It was a great achievement. All of them deserve credit.

Newton's work could even be used to accurately predict celestial events such as eclipses. It was so thorough and complete, with the certainty of mathematical demonstration combined with experimental verification, that it finally won over even the scholastics, who had previously believed in Aristotle's theory of gravity. Galileo had already softened them up a bit a few generations before, and Newton finally knocked them out. After about 2,000 years of supremacy, Aristotle's theory of gravity had finally been supplanted.

This was a huge step forward in humankind's understanding of the natural world. Newton's work was the capstone of the Enlightenment and ushered in the scientific age. There is much that could be said here, in explaining and discussing Newton's theory, and it is all very interesting; but I want to remain focused on the topic at hand, which necessitates resisting even the most interesting and important tangents. There is one part of Newton's view that is relevant to our current topic though.

On Newton's account, gravity is the force that keeps a body in orbit: without it the planets in orbit around the sun would simply fly off in a straight line at whatever speed they currently had, in accordance with the law of inertia, or Newton's first law of motion. Recall that a body in motion stays in motion unless some outside force acts upon it. Gravity is that force, and it is acting on the orbiting body continuously to change its direction and even its speed.[32] Newton compares this to a rock being twirled about in a sling. The straps of the sling act upon the rock to change its direction from being straight to being curved, but if you let go of one of the straps the rock will fly out, moving in roughly a straight path (other than falling down towards the earth) from the point at which the sling was no longer acting upon it to change its trajectory. The more

[32] Kepler discovered that for elliptical orbits the orbiting body is slowed down by gravity as it is moving away from the larger mass, such as the sun, and it speeds up when it is moving towards the larger mass, which does make sense if you think about it.

that you accelerate the rock (and somewhat depending upon the angle of release) the further it will fly when released.

Now imagine that you could fire some projectile, say a canon ball, at a 45 degree angle (which incidentally is the most efficient for acquiring the greatest distance) at ever increasing speeds. It would fly further and further. It would have the path of an arc as gravity acted upon it to eventually bring it back to the surface of the earth. But what if you just kept increasing the speed? Newton was able to intuit, and today this has been confirmed, that if you increase the speed enough the object will eventually reach what is known as escape velocity, which for earth is approximately 7 miles per second. (About 11 km/s.)

When an object has a sufficient height above the earth's surface and it is moving fast enough it could be falling towards the earth but it has so much horizontal speed that it never actually reaches the surface. If it was accelerated roughly straight up from the earth, even if the acceleration was very high, say 6 miles per second, it would eventually stop moving and fall back to the earth in close to the same spot that it was launched from. But if it was going really fast in a horizontal direction as well it will keep its straight line speed while also being accelerated towards the earth by gravity in an arc that does not end, or in other words, a circle or ellipse that is significantly larger than the planet itself. Those insights are what connects celestial motions, such as those of planets, moons, and asteroids, to the effects of gravity on objects near the surface of the earth.

Let's suppose, just as a thought experiment, that the gravitational force remained exactly the same but the speed of each of the planets around the sun increased dramatically. Having more speed would increase the planet's momentum; greater momentum means that it would take greater force to pull it towards the sun to maintain the orbit. Since the gravitational force is the same the planets would be more inclined spiral outward. They would not fly off in a straight line, as it was with the rock from the sling, because in that case the sling no longer acts upon the rock at all once it is released whereas the sun's gravity would still have some effect on the planets, but the orbits would begin to spiral. Some of the planets may at some point reach escape velocity and no longer orbit the sun at all.

What we see from this is that speed must be within a certain parameter to maintain an orbit. If a planet was stationary or even moving too slowly then the attractive force of gravity would eventually draw it in to the sun (although that could take a very long time). If it is moving too fast its motion will be deflected by gravity but not enough to keep it from eventually escaping. One wonders how many masses have been within proximity of the sun and have either been drawn into it or reached escape velocity. It is probably a lot. The planets that currently exist in the solar system are only there because there is a delicate balance between the planet's speed and its position which allows the orbit to be maintained.

Now suppose that the sun's gravity suddenly disappeared entirely. This would be just like the rock released from the sling. All the planets would fly off in a straight line at the same time. It would have an effect on Neptune just as quickly as it would on Mercury. In both cases the force holding them in orbit would be removed at the same time, so they would fly off in a straight line at the same time from wherever they each were in their orbit. This does not mean that gravity moves faster than light; gravity does not actually 'move' anywhere, it is a constant attractive force between masses that exists even at great distances, although the strength declines with distance.

In the next few sections I will be attempting to defend and build upon Newton's idea of universal gravitation by providing a more complete explanation for why matter behaves this way, based upon some of the things that scientists have discovered since Newton's time. I will also be giving more arguments for why this is a better explanation than space-time.

MY THEORY OF GRAVITY

To get a better understanding of gravity it is helpful to start by considering its effect on matter beyond just how it affects objects in motion. Let's use what is known (or currently believed anyway) about the composition of planet earth to do this. The three main layers of our planet are the crust, the mantle, and what seems to be a liquid core due to the intense heat. At the surface the average density is 2.8 grams per cubic centimeter, 1,000 miles down it is about 5 grams per cubic centimeter, and 1800 miles down it is almost 6 grams per cubic centimeter. Here there is an abrupt change where it is believed that the matter goes from being a solid to a liquid. (Although the mantle is only semi-solid because of the heat.) The density of the material jumps from 6 to 9 and then increases smoothly to 11.5 grams per cubic centimeter at the center. The pressure is estimated to range from 10,000 tons per square inch at the edge of the liquid core to 25,000 tons per square inch at the center of the earth. The pressure is so high at the very center that the material probably cannot be in liquid form. Thus, the 'inner core' is actually solid while the 'outer core' is liquid. What causes all this pressure? We will get to that later on in this section. For now, just note the pattern: the closer to the center, the denser the matter.

Even the rock in mountain ranges (further from the center) is less dense than the average density of the crust. The crust is generally composed of two main types of rock, basalt and granite, with the less dense granite riding buoyantly on the basalt.

We see the same general organization with air and water. I am not just talking about the fact that air, being composed of gases, is lighter than water and rock so it is further away from the earth's center; that is true, but even the way that the air itself is organized also shows the same pattern. Air is densest at sea level and steadily becomes thinner toward the top of the atmosphere. The atmosphere has no definite boundary, it just fades off gradually into space, but at an altitude of 150 miles it is only one ten-millionth as dense as it is at sea level, and at 225 miles, only one trillionth. At 1,000 miles it is one quadrillionth the sea level amount. Hundreds of miles up there is a layer of helium and above that an even thinner layer of hydrogen. The lower levels include heavier gases like nitrogen and oxygen as well as trace amounts of other gases such as neon, krypton, and xenon. There are also relatively heavy molecules like carbon dioxide and methane.

Early 'hot-air' balloons were made with hydrogen, which is only one fourteenth as dense as air at sea level. Each pound of hydrogen (less than 1/2 kg) could carry a payload of 13 pounds (a little less than 6 kg). Helium balloons are sometimes used today to track weather, as well as for fun, such as at birthday parties. A helium balloon rises because helium is less dense than the other elements that exist in the lower atmosphere which make up the air that we breathe. These heavier elements and molecules are pulled towards the center of the earth with greater force than the helium atoms inside the balloon, which causes the balloon to be displaced, moving it in the opposite direction. If allowed to do so, the balloon would float up to a level in the atmosphere where the gases outside the balloon are closer to the same density as the ones inside the balloon. Perhaps it sounds a little strange to say that it is gravity that causes the balloon to rise, but that is the case.

Temperature also makes a difference. Most hot-air balloons, as the name implies, simply heat up the air that is already there, which makes it less dense, and that is what causes the balloon to rise. When heated the molecules move more, which causes them to spread out a little, so the same amount of matter now takes up a larger volume. The air around it, including above, is now more dense so it is pulled down toward the center of the earth more strongly than the air inside the balloon. That displaces the balloon, causing it and the basket that is attached to it to move up.

Essentially the same thing happens with water. In the ocean, cold water tends to sink (moving towards the earth's center of mass) and warm water rises. The reason that the colder water sinks is because the molecules are slightly closer together than with warm water, which creates a stronger gravitational attraction and they are more strongly attracted to the center of the earth. But in certain regions the water is then heated up by the ocean floor, which causes that water to rise. Jet streams and strong currents in the ocean develop in part because of this. (There are also jet streams in the atmosphere similar to what is found in the ocean.)

If you accept Einstein's theory of gravity, what explains the fact that cold water sinks and denser air is found near the earth's surface? Does cold water distort space-time more than warm water? If so, why? And even if it did, why would that cause colder water to sink further down into the earth's space-time distortion than warmer water? If gravity is just a distortion of space-time then matter should fall or settle into the space-time hole in a haphazard non-organized way, just depending on when the object happens to have fallen into it, like someone randomly dropping items into a landfill. That is not what is observed. There is a very clear organization in which matter becomes steadily more dense, on average, as one moves toward the center of mass.

A balloon filled with helium would apparently not distort space-time anywhere near as much as a ball of the same volume that was composed of lead. (There is a reason why the proverbial 'lead balloon' represents something that does not go over very well.) But why would this be? It seems like if it was just based upon geometry then the volume and the external shape of the object would be all that mattered, not how dense the material is. The lead would apparently distort space-time more itself, which means that other objects would slide or fall towards it more readily, and for some reason that would also make it more inclined to fall further down into the space-time hole that is created by the earth, although I am not sure why.

If you put both of them at two meters above the ground and then released them obviously the lead ball would fall to the earth as soon as it was released while the helium balloon would rise. How could one explain the latter using space-time? Why would the helium balloon, or a hot-air balloon, move contrary to the space-time distortion, essentially moving 'uphill'? Instead of falling into the space-time hole created by the earth the balloon climbs up and further away from where there is the greatest distortion. What would account for this in General Relativity?

In many ways buoyancy in water is similar to what happens with the balloon in air. If a U.S. Navy ship that is made of steel and other dense materials were instead in the shape of a solid sphere it would not float because it would be more dense than the water. So, when the same amount of matter is in the shape of a solid sphere it creates more of a space-time distortion than the water does and is drawn into other space-time distortions more readily? But then, when it is in the regular shape of a ship, or in other words when the same material is more spread out, then the water creates a greater space-time distortion? That seems like a strange, inadequate explanation.

Now let's consider what the explanation for buoyancy would be if gravity is an attractive force as Newton believed. The determining factor for whether something floats is its density in comparison to the fluid that it is in. Water is somewhat in the middle of the scale in terms of its density compared to other matter. If an object sinks in water what is really happening is that the matter it is composed of has a greater attraction to the earth's center of mass than the water molecules that it displaces. But in some cases all that would be needed to change this is a change in the object's shape which would increase its volume without increasing its mass. Even though the object weighs the same amount as it did before it would be more spread out and thus have a lower average density. Then the water molecules would be more strongly drawn to the earth's center of mass than the atoms that make up the object so the object does not go all the way through them (though it does displace some of the water molecules), it rests on top of them, or in other words, it floats.

Even a gravel beach is organized so that the largest pebbles are on the bottom and each layer above has progressively finer material. One could say that this is because the larger pebbles are 'heavier' than the smaller pebbles and grains of sand, etc., but we have to think about what that really means: to say that something is 'heavier' means that it has a stronger attraction to the earth's center of mass (and in turn, the earth has a stronger attraction to it).

Since I began thinking about this in depth, I have noticed that sometimes it even looks like rocks are slowly sinking into sand and other types of soil that they rest on as they are drawn more strongly towards the earth's core than the sand. If a rock has been in the same place for a long time you can actually see it start to sink into the soil, similar to how it would sink in water, it just happens far more slowly.

Some scientists believe that there is a process going on with the lower layers of the earth, such as the mantle, that is similar to what happens with the ocean and the atmosphere, in which heavier materials tend to sink towards the earth's center, are heated up as they get closer to the center, and then rise once they become heated. This would of course happen more slowly than it does in the ocean or in the atmosphere, but it is essentially the same process. The rock in the mantle is solid, but the temperature is so high that it has greater plasticity than rock would ordinarily have. To me this makes a lot of sense, and I think it is pretty likely. It helps to explain a lot of geological activity such as volcanoes and geysers.[33]

I mentioned at the beginning of this section that I would discuss pressure and how it relates to gravity. Obviously there can be other sources of pressure but let's focus on the pressure that is caused by gravity. You may not notice atmospheric pressure because we are used to it, and in fact adapted for it over millions of years. But if you were far underwater you would begin to notice the pressure. Where does it come from? It is the gravitational force, pulling on all those water molecules above and around you, and you are caught in between. If one happens to get caught between a large rock and the ground it could cause serious damage as the rock presses down and crushes his body. Why does this happen? We describe it as the rock being really heavy, which means that it is hard to move and even more difficult to lift, but why? It is because the rock has so much mass that the gravitational attraction between it and the earth is very strong and it is hard to counteract it with another force, such as the force exerted by a person's muscles. Perhaps not even a group of people could move it. Unfortunately the person is caught in between the earth's center of mass and the rock's center of mass, so he gets crushed as they are pulled closer

[33] So here is a question that may have occurred to you: If the heaviest elements sink towards the earth's center of mass, why are there heavier elements that are still on and in the earth's crust at all? Scientists think that the earth's core is composed mostly of iron and perhaps some nickel. These are fairly dense heavy metals, but others, such as gold, lead, and uranium, are much heavier. Why are those elements found around the crust at all? Shouldn't they only be found at the earth's core? One thing to keep in mind here is that the pressure is very high at the core, so iron and nickel under that much pressure is more dense than iron and nickel at the surface. But for all we know there might be heavier elements in the earth's core as well, particularly the inner core, which is where one would most expect to find them. It is believed that the earth was much hotter at one point, existing mostly in a liquid state. If that is true then this is when the heaviest elements would have been most likely to sink to the center. If iron was the most prevalent heavy element on the planet at that time then this is what would come to make up the core, or most of it. But once the earth begins to cool and the crust hardens some of this material would be trapped near the surface. It would have the gravitational force pulling it towards the earth's center but it would not be pulled through the now solid rock of the crust. Loose small rocks of rare earth metals have been found in abundance in certain parts of the ocean floor. It makes sense that they would end up there because they are some of the heavier elements and that is the lowest place on the surface that there is. They cannot get any closer to the center of the earth without going through cool solid rock and the gravitational force is not strong enough to cause that. Secondly, some of the heavy elements at the surface would come from meteorites that hit after the earth had cooled at the surface. But, third, there are all sorts of chemical reactions that are constantly taking place. In most cases it is probably just that the heavier elements were formed near the surface after the earth had cooled and had a solid crust.

together. Thinking about it this way, is it any wonder that there is so much pressure at the earth's core, with all that matter above pressing down?

A familiar theorem in Newtonian mechanics is that the gravitational force of masses in a sphere on bodies outside of it is the same as the force due to a point with equal mass located at the sphere's center. This is obviously an abstraction: it is not really the case that all of the mass is located at the sphere's center, but mathematically it behaves as if it was. Why is this? I believe it is because if the smaller object was at the sphere's center of mass it would completely balance out the gravitational force that all of the atoms that compose the sphere are exerting on that object. There would be a lot of pressure on it from all directions but the force would be balanced so the object would no longer be moved in any particular direction once it reached and finally settled at the center of mass. Until that happens (it rarely would in a real life example) the object is drawn towards the center of mass.

Everything seems to be organized this way on earth, and also on other planets. The densest materials have the strongest gravitational 'pull' and are also 'pulled' the most themselves by other masses. The question is why? What makes gold and uranium 'heavier' than helium and oxygen? It does not have anything to do with space-time. It is actually because of the relative size of the nucleus of the atoms. Heavier elements tend to have relatively large atomic nuclei, meaning that there are a lot more protons and neutrons, and often those nuclei are densely packed into a relatively small volume. The heaviest elements tend to be solids, at least at ordinary temperatures.

It seems apparent that the gravitational force must have something to do with protons and neutrons. Elements that have the most protons and neutrons are the densest materials and these also have the strongest gravitational attraction.

The current theory in physics is that there are four fundamental forces: the strong force, the weak force, the electromagnetic force, and the gravitational force. However, I believe that gravity and the strong force are actually different manifestations of the same force.

The strong force is believed to only be a significant factor at the quantum level because while it is very powerful in binding atomic nuclei particles together it drops off dramatically in strength with only a little bit of distance between the particles. But gravity has a similar characteristic, it gets weaker with the square of the distance between the masses, which means that the strength of the force drops off rapidly with distance. It never completely disappears, though, it just gets a lot weaker. Suppose that the strong force has the same characteristic: it would turn into the gravitational force with greater distance. The force is by far the strongest when the protons and neutrons are really close to each other, but I do not think that it ever completely goes away when the particles are separated.

Gravity is a very weak force in comparison to the others. (Think about how much stronger the magnetic force is in a natural magnet than the gravitational force created by that same small rock and another object of roughly the same weight.) Although the force is weak by comparison, it is not zero, and that is the key. Even a very small force multiplied by the number of atoms that compose the earth would be quite substantial, let alone what is created by the sun or even larger stars. The number of atoms that compose the sun at any given moment is finite, but it is so large that it would be incomprehensible to humans. That many atoms grouped together creates a very powerful combined force.

My hypothesis, then, is that gravity is the strong force attraction of protons and neutrons to each other. Because the protons and neutrons are more spread out from atom to atom than when they are joined within the nucleus the attraction that one nucleus has to another is quite small but when there are a huge number of atoms grouped together it can add up to be quite significant. The total force is increased if the number of protons and neutrons is increased and/or they are more condensed and thus closer together; the latter is why matter that is more dense is considered 'heavier' and the former is why very large bodies composed mostly of gases that are not very dense, such as the sun, still have a strong gravitational attraction to and for other matter. Protons and neutrons attract other protons and neutrons even from great distances (especially when it is large masses of them attracting other masses of them) though the attractive force grows much stronger as they get closer. This is what causes matter to clump together.

Newton's law of universal gravitation stated that every particle attracts every other particle in the universe. That is true if we define 'particles' as 'atoms', or just small bits of matter, as they would have been thought of in Newton's day, but we have more refined distinctions now, so I would say that it is specifically protons and neutrons that are attracted to each other. Electrons are not attracted to one another. In fact, like charges repel. This is what maintains the distance between the atomic nuclei. The attractive force is not very strong when the nuclei are even that far apart, so the magnetic force, in which protons and electrons are attracted to each other, is stronger, as is the repulsive force between negatively charged electrons. The two nuclei cannot get any closer without losing electrons and the attractive force is not strong enough to cause that. Perhaps the interplay between these forces is part of what gives atoms their characteristic 'wiggle' or movement.

Later in his life Einstein attempted a very ambitious project. He wanted to come up with a grand unified theory, or 'theory of everything' that would explain all physical phenomena. He found that he was able to unite three out of the four fundamental forces but he could not figure out how gravity fit in. He was, of course, thinking of gravity as being caused by distortions of space-time. Ever since then physicists have been struggling with essentially the same problem, which is described today as how to unite the Theory of Relativity with quantum mechanics. Physicists working in quantum mechanics also have struggled to explain how gravity fits in. They have speculated that perhaps there is a fundamental particle known as a 'graviton', but so far it has not been discovered. Personally, I am skeptical that there is such a thing. I think one reason (there are others but I do not want to get off topic) that it has been such a struggle is because Relativity's explanation of gravity is wrong. More progress would be made if scientists stopped trying to unite the two theories and simply abandoned Relativity.

Some physicists have suggested that the electromagnetic force could be combined with the weak force to create the 'electro-weak force'. Unfortunately I am not really in a position to evaluate this claim. I don't have the training (and maybe not the ability even if I did have the training) to follow the math in the argument to see whether this really works. But the weak force is related to charge, so it seems intuitively plausible to me. If that is true, or some form of it is true, and one could also unite the strong force with gravity, then one would end up with two fundamental forces rather than four. There would be a certain elegance in the fact that the 'gravitational-strong force' would be related to quarks, which is what protons and neutrons are made of, and the 'electro-weak force' would be mostly related to leptons, such as electrons, although it would also be related to how the leptons interact with quarks. To me this seems like a promising line of inquiry for a true theory of everything, particularly if one could also explain how and why the two types of particles form.

Newton's inverse square law describes how gravity gets much weaker with greater distance but it also shows how it gets a lot stronger as two bodies get closer to one another. In fact, the inverse square law is even in effect within the mass itself. A body with the exact same amount and type of matter (meaning the same number and type of atoms) that is more tightly packed into a smaller volume has a stronger gravitational field than one that takes up a larger volume. This is another reason why I believe gravity is related to the strong force. The more tightly packed the matter is the closer that the atomic nuclei are to each other and the stronger the force becomes. Not only do the nuclei have a stronger attractive force between them when they are closer together, but collectively they also have a stronger attraction with other bodies of matter than they would if those same nuclei were more spread out.

This explains why cold water sinks and warm water rises. According to the kinetic theory of heat, as a substance becomes hotter the atoms move more. It also seems to be the case that some of the electrons move to higher energy levels which would cause the atom to take up more space. This is probably due to atoms colliding and electrons from each coming near each other and then being repelled and/or electrons entering and leaving the atom which then disturbs and causes movement in the electrons in other atoms. If electrons are moving more and moving faster there will be more of them found in higher energy levels. Because the atoms then take up a greater volume the atomic nuclei are slightly more spread out than they are in cold water. The cold water has a stronger attraction to the center of the earth so it is pulled in that direction which displaces the warm water, sending it in the opposite direction. This is also why a hot-air balloon rises when the air inside the balloon is heated. When heated the air molecules inside the balloon take up a larger volume. It could be the same material with the exact same number of air molecules, but when the nuclei are more spread out there is less gravitational attraction than with air molecules at lower temperatures.

Elements with higher atomic numbers (and higher atomic mass numbers) are generally considered to be 'heavier'; these elements have more protons and neutrons packed into a smaller volume. Generally speaking the more protons and neutrons that are present in a material the stronger the gravitational force will be. Even isotopes of an element that have more neutrons are 'heavier' than isotopes that have less neutrons, which proves that it is both protons and neutrons which are the cause of the gravitational force, not just the protons. Of course that just confirms what we already knew, because protons and neutrons would not be attracted to each other unless neutrons were also affected by and themselves caused the gravitational force.

In section 11, I argued that matter and energy are not really equivalent. One objection that could be raised to that has to do with nuclear fission. In a nuclear fission reaction, a uranium atom nucleus splits into atomic nuclei of smaller size (isotopes of barium and krypton), and other particles such as neutrons. What can trigger a uranium atom nucleus to fission in the first place is an impact with a neutron. When the nucleus splits, it releases more neutrons. These neutrons can then initiate the fission of further uranium nuclei, and so on. If nothing restricts the process it is an uncontrolled chain reaction which releases a huge amount of energy, an atomic bomb. However, scientists have found ways to slow down the chain reaction in nuclear power plants so that there is a more controlled release of energy in the form of heat. That heat can be used to do things like boil water to make steam to drive electric generators.[34]

It turns out that the total mass of the decay products mentioned (isotopes of barium and krypton along with other particles) is just slightly less than the mass of the uranium nucleus. This 'missing' mass is around a tenth of one percent of the original mass. Scientists interpret this to be evidence that matter has been converted into energy by the reaction.

My explanation for the phenomenon is different. My theory is that the gravitational/strong force is weakened when the protons and neutrons are more spread out. This accounts for why the components weigh slightly less when split apart than the uranium nucleus. This difference in weight or gravitational pull towards the center of the earth would be interpreted as being due to a difference in mass by someone who believes in Einstein's theory because that is what they would be looking for and expecting, but the component parts do not really have less material.

BLACK HOLES

An idea from physics that has really captured the public's imagination is that of black holes. Einstein did not come up with the idea, in fact he resisted it at first. He seemed to regard it as someone taking his view to an extreme, which actually is a pretty accurate description. But later scientists came to believe that black holes were a natural extension of General Relativity.

There is a fair amount of evidence that black holes do exist, at least in some form, with scientists even claiming to have observed one recently. They are thought to exist at the center of galaxies, although I wonder if maybe in some of those cases it is not really a black hole, that is just the center of mass for that galaxy. For example, supermassive black holes seem to exist only in

[34] I got this information from *Einstein for Everyone* by John Norton, chapter 7.

galaxies of an elliptical shape, with a dense bulge of stars at the center. But is it really a black hole, or is it simply the galaxy's center of mass, where one of the foci of the ellipse would be located, which is offset from any particular star because there are many of them clustered together? I am not sure.

There could be something like black holes even in Newtonian physics, but they would have different characteristics than in Relativity. This type of black hole would not be a distortion of space-time. In Relativity the reason that it is called a 'black hole' is because it is such an extreme distortion or warping of space-time that whatever falls into the 'hole' can never get back out, even light. Models of it make it look like a large funnel, although I do not think that would be completely accurate because it would have to be a funnel in all directions at once, which cannot be easily visualized.

A Newtonian 'black hole' would just be an extremely dense mass. This is in harmony with the theory of gravity that I discussed in the prior section. When a mass is more densely packed, or in other words when protons and neutrons are closer together, it creates a much stronger gravitational force.

Earth's escape velocity is 11 kilometers per second (approximately 7 miles per second). If the radius of the earth was reduced by a factor of 100 (from 6500 kilometers to 65 kilometers) the escape velocity increases by a factor of 10, or 110 kilometers per second; if earth's radius was reduced by a factor of 10,000 the escape velocity increases by a factor of 100; if the radius is reduced by a factor of 1,000,000 the escape velocity increases by a factor of 1,000, and so on.[35]

The Relativity model suggests that a black hole has zero radius, 'infinite curvature' because it is a point, and 'infinite density'. But a point is not a little circle - it is no more a circle than it is a square, or triangle, or any other extended body - a point does not have a radius or curvature.

Those who believe in the Relativity version of black holes have some very wild and fanciful ideas about what they would be like. Some well-respected leading scientists who are ordinarily sane have even speculated that maybe we are inside of a black hole right now and we don't even know it because Relativity says that the reference frame's space and time always appear normal to an observer inside the frame. Others speculate that the black hole could be a pathway into a new dimension or alternate universe. Popular movies that are based upon these scientific views suggest that near a black hole (with the aid of more technologically advanced humans) one could observe and send messages to people in other time periods because of the distortion of time.

According to Relativity, if a spaceship was going into a black hole what the passengers would observe would be very different from what observers in a different reference frame would see. It is said that for an observer in the spaceship the outside world would appear to speed up and huge amounts of outside time would elapse in the short time the spaceship would take to reach the

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[35] See *Einstein for Everyone* by John Norton, chapter 32 on black holes.

event horizon.[36] The final stage of the journey would be completed extremely rapidly as the spaceship reached the 'singularity'. To an outside observer the spaceship would appear to fall rapidly towards the black hole at first. But as it got closer, it would slow and eventually freeze just outside the event horizon. In the entire lifetime of the outside observer, the spaceship would never actually reach the event horizon. That would be true even if the observer lived and observed indefinitely.

I obviously do not believe any of this. Time would not be affected by a black hole. Space would not be affected either because 'space' is not a material substance. It is only other bodies of matter that would be affected, and the only effect is that there is a stronger gravitational attraction. That is all. Let's leave the science fiction behind.

Even the name is a misnomer: it is not really a black 'hole', as in a hole in space-time, it would be an extremely dense mass that creates a very strong gravitational field. I will call them ultra high density masses instead. (It is not quite as catchy, but far more accurate.) The volume would be small relative to the mass it contains, but the volume could not be zero, and the density would be incredibly high, but it would not be infinite.

It is believed that black holes form because the gravity becomes so strong that it collapses in on itself and once this process starts nothing can halt the collapse. But I believe there would be a limit to it. If nothing else, the collapse would stop once all the protons and neutrons were bonded together in essentially one giant nucleus. But in most, if not all cases, it would probably be halted even before that by other forces. The extreme pressure may cause some matter, particularly leptons (which are not subject to the gravitational force when they are free from quarks) to be expelled violently, and it would be so intense that it could cause other reactions, such as intense heat and/or an explosion.

There is ordinarily a lot of space (relatively speaking) in an atom between the nucleus and the electrons. I learned from a book by Isaac Asimov back when I was in high school that if the nucleus was the size of a football the atom as a whole would be approximately the size of a pro

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[36] This is according to John Norton in *Einstein for Everyone,* chapter 32. However, I am not entirely sure this would be true. Wouldn't that violate the Principle of Relativity? If observers see huge amounts of time passing very quickly for all the reference frames around them they would have to know that something was going on. They should be able to deduce that either they are moving very fast or they are experiencing high gravity, especially if they were aware that they were near a black hole. I don't necessarily blame Norton for thinking this way - the theory itself is unclear on this point. But I wonder if Relativity is actually committed to saying that the passengers in the ship would see their own time as normal and see time slow down dramatically for all of the reference frames around them. I say that because time speeding up is not supposed to be an observed effect of Relativity. Time dilation only goes in the direction of time slowing down for other reference frames. If you were to observe time slowing for the reference frames around you, you could still assume that you are at rest, and/or experiencing 'normal' gravity, which the Principle of Relativity requires, and believe that it is the other frames that are in rapid motion or experiencing extreme gravity rather than you. But if the observer in the ship is able to perceive time speeding up by a huge amount for all the reference frames around her she could not legitimately think that she was at rest, and/or experiencing normal gravity.

football stadium. Presumably the matter in one of these ultra dense bodies would be so condensed that there would be little if any extra space.

If indeed ‘black holes’ do exist at the center of galaxies, at least some galaxies and some planetary systems - which seems possible, perhaps even probable - here is how they would form. The matter of the entire galaxy would be mostly in clouds of gas and dust swirling about, though there could be some of it that is more dense. The matter that is near the center would gradually be pulled in towards the center of mass for the entire galaxy. Perhaps there would be something more dense, such as a star or a star that has cooled, which would be pulled to the center of mass and it would be steadily accumulating matter the way that a snowball rolling downhill acquires more snow, although it would not be getting much bigger in terms of volume. As the matter accumulates the gravitational force becomes stronger, and it would develop into an ultra dense mass if it was not one already. The matter which is out near the middle and the edges of the galaxy would be far enough away from this ultra dense mass and it would be moving fast enough that it would not be pulled in. But that ultra dense mass would hold the rest of the matter of the galaxy in orbit. New stars and planets would form in the middle and outer edges of the galaxy by accumulating matter as well, but obviously not nearly as much. Ultra dense masses at the center of galaxies would be some of the largest, equivalent to ‘supermassive black holes’; they could actually be quite large even in terms of volume, it would depend on the galaxy, but their volume would be small in comparison to how much mass they contain. They would likely contain a fairly large percentage of the entire mass of the galaxy.

Most ultra high density masses would probably come from large stars that have run out of fuel and cooled, which causes the atoms to be attracted more strongly to each other (think of a balloon with hot air versus a balloon with cooler air) and the star has such a strong gravitational field already from having so many atoms near each other that gravitational collapse begins when it starts to cool.

Our own sun is probably not big enough to become one of these ultra high density masses when it runs out of fuel; it will instead ultimately be a black dwarf, which is similar, but not as large. That gives us some idea of just how big these stars were at one time. Our sun is composed mostly of hydrogen and helium; it is a very large ball of very hot gas, which takes up a lot of volume. But at cooler temperatures the atoms are not moving as much, which decreases the pressure, and the gravitational force pulls the atoms towards the center. As the nuclei of the atoms get closer to each other the gravitational force increases even more. One can imagine what would happen if all of this material was compressed into only 1/10,000th, 1/100,000th, or 1/1,000,000th its current volume. It would create a much stronger gravitational field than the one that the sun currently has. That means both that it would take more force to move it and also that it attracts other masses with greater force.

The atoms in such a mass would resist being moved because they are so strongly attracted to each other that it would be very hard to separate them, and the sheer number of protons and neutrons that are in close proximity that would need to be moved is enormous. It would take a very strong force to do either of those things. One could not move any of them (at least not very much) without moving all of them, and there are many many atoms that must be moved. It would likely take a star or another ultra high density mass to have much of an effect on it.

According to Newton's theory there is always some effect on both masses - the planets have an effect on the sun, and even small objects falling to the earth do attract the earth, but when there is such a huge difference in mass between the two bodies the smaller one has much less of an effect on the larger body. That would certainly be the case in this instance. This would likely lead to an ultra high density body accumulating matter as other masses are attracted to it. Don't expect it to get much larger in terms of volume though. Any new matter would be strongly contracted into a much smaller volume as well.

It would be interesting to study one of these ultra high density masses up close, but if you got too close the matter inside of you and the matter that made up your spaceship would be pulled apart and sucked in to become part of the ultra dense mass. That is why it is absurd to claim that we could be in a black hole right now. If you were, the tidal forces would tear your body apart. So also if you were too close to one of these ultra high density masses. That is an objective fact; if you got too close it would kill you in all reference frames.

Black holes are said to be black because not even light can escape them. I don't think that light is affected by gravity in the same way that masses are, so I don't think that would be completely accurate. It is quite likely that there is more dense matter around a black hole than in other regions of space so the 'bending' of light that may occur around one is probably refraction (see p. 110-112) rather than directly because of the gravitational force. The main reason that these ultra dense masses would be difficult to detect from great distances is because they have a relatively small volume and they would not be illuminated as the stars are.

Finally, I would like to close out this section with a general comment about the gravitational force. Gravity accelerates objects. If a mass has inertial motion in a straight line gravity will deflect it. One might expect that the the greater the mass of a body the greater its deflection; that is what the Aristotelians thought in the time of Galileo. But Galileo, from idealizing and abstracting from his experimental results, realized that lighter objects actually fall at the same rate as heavy objects in a vacuum, it is only air resistance that causes them to fall more slowly in our everyday experience. Newton incorporated this result into his own view so that the greater mass of the body was precisely compensated for by greater corresponding inertia. All bodies in free fall, whether heavy or light, have the same trajectories. Defenders of Relativity argue that Einstein gave a better explanation for what they consider to be an otherwise 'curious coincidence' by putting the trajectories of free fall into the context of space-time. (Einstein made a similar point himself in *Relativity The Special and General Theory* when he spoke of the chest that was being accelerated upward. He noted that all objects inside the chest would 'fall' to the floor at the same rate.) Bodies, they argue, whether light or heavy, follow the same trajectories because it is the earth's space-time distortion that is causing the fall for all of them. In a sense, it would be like having them all slide down a hill at the same speed, no matter their size or weight.

However, this argument may be based upon an overgeneralization. Objects do not fall as fast on the moon as they do on earth, which shows that the amount of acceleration does vary. In fact, the rate at which objects fall even varies slightly on earth based upon whether you are near the poles or at the equator.[37] Galileo was correct that there is not enough of a difference in size with everyday objects to notice a real difference in how fast they fall here on earth. But the objects that he was experimenting with were all very small in comparison to the mass of the earth; there could be a difference when the size disparity is much more extreme, say if you were comparing how fast the planet Venus would fall to the earth from 5 km away to how fast an object that weighs 2 kg would fall. Venus would be big enough to pull the earth towards it as well, but I doubt that it would 'fall' as fast (even in a vacuum) as the 2 kg object because there is just so much more mass to accelerate. It would be more of an equally balanced tug of war between the two masses in that case, so I think Venus would 'fall' more slowly. This is implied by the law of inertia. It requires more force to accelerate a larger mass. But the gravitational force coming from the earth would be the same for both objects. Therefore that force would not change the speed and direction of a much larger object (Venus) as quickly or as much as it does for the smaller object. In other words the deflection of the larger mass would be less. (Note that this is the opposite of what the Aristotelians of Galileo's day were saying.) Jupiter would not 'fall' to earth at all (or at least not much); in that case the earth would be the smaller object that is accelerated towards it. The speed of the acceleration would vary in cases like that. If earth was being moved by an ultra high density mass from the same distance away it would be accelerated at a faster rate than if it was accelerated by Jupiter. It is the difference in the amount of mass of the two bodies that would determine the rate of acceleration for the smaller one. I do not think that one could use this as evidence to prove or to disprove General Relativity. But it does weaken the claim of the equivalence of a gravitational field to an upwardly accelerated reference frame.

ANT-MAN

There is a long history of shrinking people in science fiction. Some movies that quickly come to mind are: *Honey, I Shrunk the Kids*, *Downsizing*, *Fantastic Voyage*, etc.[38] Few of them go into

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[37] According to Morris Kline, it is 32.257 ft/sec^2 at either pole and 32.089 ft/sec^2 at the equator. See *Mathematics for the Nonmathematician* p.352.

[38] There are even some scientists who actually want to do it for real if we could figure out how. They think that it would be better to combat climate change because we would pollute a lot less per person if we were smaller. Personally I think it would be a horrible idea, even if we could do it. I don't know about you, but I would not want to become rat food, or have to worry about the house cats in the neighborhood, or maybe scariest of all, the snakes. Not to mention the birds and the fish that would suddenly seem like apex predators to you. We would be on the menu for a lot of critters if we were really small. Even if adults were shrunk down to the size of a two-year old child (which would probably not be enough to make a real difference with climate change) the world would be a much scarier place for us than it is right now. This is a perfect example of really smart people coming up with crazy ideas. I'll stay full size, thanks. Let's come up with a different plan to combat climate change and excessive amounts of garbage.

the details of exactly how the shrinking is done. One notable exception to that, though, is the comic book, and later movie, *Ant-man*. I happened to see this movie on TV while working on this project. According to the story (the movie version), Ant-man is shrunk not by reducing the number of atoms in his body but by reducing the space that each of those atoms take up. Somehow this is supposed to give him super powers, although I am not exactly sure why. You can tell when watching the movie that the script writers could not decide how much Ant-man and other items weigh when they are shrunk. They say in one part of the movie that Ant-man weighs 200 pounds when full size, so one would assume that he would weigh at least that much when he is small, since it is still the same number of atoms that compose his body they are just compressed into a smaller volume. Actually, according to the inverse square law and what we discussed in previous sections, he should 'weigh' more when he is small than when he is full size. Yet in other parts of the movie it is clear that Ant-man is supposed to weigh about as much as an ant when he is small, such as when he rides on the back of a flying carpenter ant named 'Antony'. In another part of the film, Michael Douglas' character, who is the older Ant-man, carries around a small military tank on a keychain that looks like a plastic toy. We find out later though that it is an actual tank that he has shrunk down, because towards the end of the movie he brings it back up to full size in order to break out of a building, which shows that it was a real fully functional tank. But wait, if the tank was shrunk by reducing the space that exists within the atoms then it would have to weigh at least as much as when it is full size, and really, according to Newton's inverse square law, it would weigh significantly more when all of its atoms are condensed into a smaller volume. You definitely would not be able to put it on a keychain and carry it around with you in your pocket.

There are other examples from the movie which indicate that when something is shrunk it weighs about what one would expect of an object that size, which is usually pretty light. Yet the shrinking is supposed to be accomplished not by eliminating matter, or changing the composition, but by making the same amount of matter more dense. That does not add up.

I realize, of course, that superhero movies are just for fun. Certainly Ant-man is no more unrealistic than most of the other superhero stories. I guess you have to give the writers some credit for even attempting to give some sort of plausible scientific explanation for how the shrinking is accomplished. I have certainly gotten some things wrong before in my own writing, and it is a little embarrassing, but writers cannot know everything, as much as we might try, and as much as other people expect it. I would never write a story set during the Civil War because if you got even the slightest historical detail wrong, no matter how trivial, the Civil War buffs who do all the reenactments and have a model of all the battles in their basement would kill you for it. People don't get that the setting is just like the painted background scenery of a play. It is not nearly as important as the story itself, which of course would be true for *Ant-man* as well.

Nonetheless, I think it would be helpful in understanding gravity better to show how the movie got it wrong, so I guess I will risk being a know-it-all to explain what I think it would really be like to be Ant-man. If he was shrunk by the method that the movie identifies the matter composing his body would be more dense than when he is full size. He would actually weigh more when he is approximately the size of an ant than when he is at his normal size. This is a little counterintuitive because we don't have much experience with things that are really small yet very heavy, but it is true.

After being shrunk Ant-man would actually have a really hard time even standing up and walking around, if he could do it at all, let alone jumping incredibly high relative to his size, and many of the other extraordinary feats that he does while small. For him, it would be like being on a planet with much stronger gravity. You have probably seen footage of astronauts taking advantage of the fact that the moon has weaker gravity than earth to bounce around and jump with ease; it would be the exact opposite of that for Ant-man when he is small.

One benefit that Ant-man would have, though, if he did manage to stand up, say through a technologically advanced suit or something, is that if someone punched him he would be so much more dense that he would probably go right through that person's fist like a nail. This would be true even if he had jumped in the air (with the help of that special suit) because it would take more force to accelerate him than to go through the soft tissue of the assailant's body. To easily win the fight Ant-man could simply jump on the bad guy's neck or shoulder and allow his great weight to pin the assailant to the ground. It would hurt a lot and may cause serious damage, though, because all of his weight would be concentrated into one small area on the assailant's body. It would be like having something that has the weight of a boulder but is only the size of an ant dropped on you unexpectedly.

However, if Ant-man was in sand he would have serious problems; he would sink really far down. If he was in water he would not be able to swim enough to keep himself afloat. He would be so much more dense than the water that he would not be buoyant at all; he would sink in the water molecules much like a full-sized person does in air. The gravitational pull on the atoms that make up his body would be much greater than on the water molecules so matter would naturally organize itself so that he was closer to the earth's center than the water molecules.

If Ant-man was on a gas giant planet, such as Saturn, he would go right through the gas. Because there is no solid rock on the surface, as there is on earth, he would just keep falling towards the center. If he had a lot of speed built up he would overshoot the center but eventually he would be drawn back to it. If he was the densest thing on the planet eventually he would end up at the center, though it might take a long time for that to happen.

This thought has caused me to wonder if gas giants and even stars slowly acquire a core of the densest material. As asteroids hit they would sink into the gas. An asteroid would not stay near the surface of a gas giant as it does on earth because earth is a solid at the surface and the rock provides material resistance to it sinking towards the earth's center. It seems likely that with a gas giant or a star the asteroid would sink completely to its center or until it becomes buoyant because the material below (meaning towards the center) is more dense than it. The escape velocity would be so high for most of these planets, and especially for stars, that it is very unlikely that the asteroid would go completely through the gas and escape out the other side. So where else would it be? It has to still be there somewhere and if there is nothing more dense on the planet then it would eventually be at the center. Thus Jupiter, Saturn, Uranus, Neptune, and even the sun could have a small core composed of material that is more dense than the gases that they are mostly composed of, which they would have accumulated over the course of billions of years. Personally, I find that to be an intriguing idea.[39]

That consideration would change our speculation about Ant-man on Saturn a little bit; instead of having only gas to contend with he might also run into a small core composed of elements (likely metals) that are heavy relative to the gases that make up Saturn, as he got close to its center. One would also expect heavier gases towards the center than at the surface, similar to the organization of earth's atmosphere.

Another trick that Ant-man has in some of the other superhero movies that he is in, such as *Captain America: Civil War,* is to make himself really big. If this was accomplished by doing the opposite of what makes him very small, in other words by increasing the space within his atoms without increasing the number of atoms, then while he would look intimidating he would not actually be a very effective fighter. Even though he might be 40 feet tall he would weigh significantly less than 200 pounds. He would be almost like a giant balloon at the Macy's Thanksgiving Day Parade. Even a strong wind could give him problems. He would be very buoyant in water though.

Part III
Light

WAVE-PARTICLE DUALITY

The current theory of light, which was derived from Einstein's work, is that light is both a particle that has zero mass, now known as a photon, and a wave. (Actually, according to the most well-accepted interpretations of quantum mechanics, everything is both a particle and a wave, but here we will stay focused on light.)

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[39] According to Morris Kline, the average density of the material that makes up the sun is 90 pounds per cubic foot. For comparison, a cubic foot of water has a mass of 62.5 pounds. So the sun has an average density of about 1.5 times that of water. (See p. 351.) The sun is thought to be composed mostly of hydrogen and helium, and it probably is, but these are lighter than water molecules so there must also be heavier elements as well that bring up the average density. The interactions that take place within the sun may actually be creating these heavier elements, but I think it is also possible that asteroids and other celestial bodies that are drawn into the sun could also provide some of the material that would make up a relatively small heavier core. The sun and gas giant planets may have even formed with a dense core.

I am skeptical that anything could be both a particle and a wave. I highly doubt that photons even exist. Supposedly they cannot slow down to any speed less than the speed of light, so they are not really observed as particles, it is just inferred that they are particles. One reason is that light seems to have momentum. But why would a particle with zero mass have momentum? Momentum = mass x velocity. It seems like this reasoning is relying on mass energy equivalence, which, as discussed in earlier sections, I do not accept.

What I really don't like about this model is that it makes it seem like if you zoomed in on the lightwaves they would be composed of photons that are little projectiles, like BBs that are shot out of a shotgun. (This is its particle nature, but each one would also have a wavefunction or a wave component.) That is not how waves work. There could be discrete elements that make up the wave, in fact I will argue later that there are, but they would not travel with the wave as projectiles.

Here is another weird thing implied by Relativity: because a photon always travels at the speed of light, $t = 0$, meaning that no time ever passes for it. That would mean that it could get from earth to Mars in literally no time (according to its own reckoning of time) and to Pluto in no time at all, as well as hundreds of light years away, or really anywhere in the universe. So is it at every spatial location at the same time according to its own account of time? Remember that this would be an actual state of affairs, according to the theory, because photons are supposed to be real things that do travel at the speed of light, in fact they are light. Relativity says that a human observer could not be accelerated up to this speed, but a photon would be moving this fast in actuality, so this is really how time would be experienced by it, or by anything moving at that speed. Does that even make sense? The whole idea seems bizarre.

Another part of the current theory, once again based upon Einstein's views, is that light can move through a vacuum. That would make it unlike any other wave that we know of, and actually I don't think that it would even make sense to call it a wave if that was true. But we will get into all of that in the next few sections.

THE MEDIUM

Light is not a particle, it is only a wave. Light waves are only a small slice of all the electromagnetic waves that exist, which include radio waves on the low frequency side, and ultraviolet, X-rays, and gamma rays on the high frequency high energy side. The visual spectrum of colors fall near the middle in terms of frequency and energy. (Being able to detect these waves must have been the most useful to our ancestors for survival, or at least it was included in an overall package of the most useful genetic characteristics.)

I do not believe that it is possible for light or any other wave to travel through a vacuum. I define a vacuum as space which is entirely devoid of matter.[40] Perhaps the fact that light is thought to be a particle with a corresponding wavefunction helps to explain why scientists believe that it could move through a vacuum, because a projectile could move through a vacuum (although it would no longer be a true vacuum in that case) but this is a very complicated unlikely explanation for how it really works.

A wave is best defined as a periodic disturbance of the medium. If there was no medium there would be nothing there to disturb. Along with all other waves, electromagnetic waves are a displacement or disturbance of the material that it is moving through. A wave transfers energy; in a way the wave *is* energy, because the energy is that disturbance. Each medium that the wave moves through would be composed of discrete elements (air and water, for example, are composed of atoms and molecules) but these particles do not travel with the wave as projectiles. It is more like 'the wave' at a sporting event: individual people stand up and sit down, but no person moves in a horizontal direction along with the wave.

In addition to light, heat is also transferred across the wide expanse of outer space. Even if you believe that light could traverse a vacuum because you think of it as being composed of projectile-photons, we ought to consider carefully whether heat could really be transferred through a vacuum.

According to the Kinetic Theory of Heat, the particles that objects are composed of are in constant motion. In general, solid materials have particles that are more densely packed than liquids, and liquids have particles that are more densely packed than gases. In solids the particles jiggle and vibrate but they are confined to roughly the same spot. Heat can be transferred through conduction, meaning particle to particle, but the particles do not flow. In liquids and gases the particles can flow and move about more easily, which is why liquids take the shape of their containers and gases tend to spread out to fill the available space. Here convection is the usual way that heat is transferred. When heat is added to a substance the particles that make it up move faster, and more, which causes them to take up more volume. That is why materials tend to expand when heated.

As a pot of water is heated the stove burner heats the metal pan mainly through conduction. As the water near the bottom of the pan is heated the particles spread out and the water becomes less dense. In part this is due to collisions that send them further away from each other but it is also because the electrons move to energy levels further away from the nucleus which gives the atom greater volume. More motion causes more and greater collisions, both between atoms, and within atoms, as electrons are sent into the orbitals of other atoms, which causes all sorts of action as

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[40] We talked earlier about heavy objects and lighter objects falling at the same rate in a vacuum. This would not necessarily be an actual vacuum in the strict sense, it just means that air has been removed. Here I am talking about a true vacuum, which has to be what Einstein meant because it is obviously true and therefore trivial to say that light can move through space that does not contain air.

electrons are jostled about, sending them in all directions, sometimes even out of the atom which causes a disturbance of other atoms.

Negatively charged electrons are attracted to positively charged protons but when other electrons are coming into that space it creates instability as the electrons repel each other. Thus heat causes greater instability. In this case it would start with the movement of the particles in the metal burners coming into contact with and disturbing particles in the metal pan. Water molecules that come into contact with the metal pan are then disturbed by the motion of the particles that make up the pan. As the water molecules and the particles that make them up move around more the nuclei become a little bit more spread out than water at a lower temperature and this water is slightly less dense.

The water that is lower in temperature (near the top) is now more dense than the water below it so this water sinks towards the earth's center of mass because it now has a slightly stronger gravitational attraction, which then displaces the warmer water below it, sending that water up to the surface, or away from the earth's center of mass. Once this water has more distance from the burner and the bottom of the pan it begins to cool (stabilize), transferring a lot of its heat to the air and other particles around it. Once it has cooled off it begins to sink to the bottom of the pan, with the warmer water below it rising, and the cycle continues, creating a convection current.

It is obvious that in order for conduction or convection to take place there must be matter. Heat could not be transferred in either of those ways through a large vacuum. But it is believed that radiation can transfer heat through a vacuum as well as light. It is thought that when an atom absorbs a photon this causes one of its electrons to move to a higher energy level and when the electron moves down to a lower energy level this emits a photon. I guess I cannot disprove that theory, but I do not see why light would take the form of a wave at all rather than simply a cluster of particles (photons) if that is really how it works. I think there is a better explanation.

Let's go back to that burner on the stove. Obviously if you were to touch it with your hand that would transfer heat directly through conduction, enough that, depending upon the temperature, it would probably do damage to the cells in your hand. But one can feel the heat even without actually touching the burner. Air is a pretty good insulator, so not nearly as much of the heat is transferred to your hand from the air as there would be if you touched the burner directly, but you can definitely feel that it is there if you put your hand over the burner even if you cannot see any other indication of heat. We have evolved to be able to perceive heat just as our eyes have evolved to sense electromagnetic waves on the visual spectrum. Obviously this would be of great evolutionary benefit: too much heat is dangerous, but we do need some of it. One can feel that sitting next to a campfire or laying out in the sun. It is a form of energy, which biological organisms need.

If heat is the movement of atoms and molecules and the movement of electrons within and around them then the way that we feel it through the air must be from the atoms in the object disturbing the air molecules around it, which results in waves, and this is what our senses perceive. Air has relatively large atoms and molecules so it takes a lot of energy to displace them and air is somewhat of an insulator, but the essential point is that the way that heat is transferred from the stove, or the fire, or a light bulb, etc., to you, without you touching it directly, is through the air; it is the air that touches you both. The air molecules are the medium through which heat is transferred.

I believe that essentially the same thing is happening with heat from the sun. If there were millions and millions of kilometers of empty space between the sun and us its heat would be self-contained. Heat is the movement of particles; if there were no particles between the two bodies then the heat would not be transferred from one to the other.

What I am suggesting here is that there are really only two ways of transferring heat, conduction and convection, and actually those are interconnected as well. The waves come from the displacement of the particles that make up the medium. The particles that compose the sun affect the particles that make up the medium, in some cases through collisions, but other times it is just charged particles repelling and attracting other charged particles. This disturbs the particles that compose the medium, causing them to vibrate and oscillate, which creates the waves. Once a wave reaches the earth's atmosphere it displaces the molecules that make up the atmosphere, and the electrons within them, until eventually it gets to you. There has to be a medium that bridges the gap from the sun to us just as air bridges the gap between the stove burner and your hand.

I will admit that it is astonishing to think about heat from the sun being transferred to me on a warm summer day, tiny particle to tiny particle, over 150 million kilometers in just a little less than eight and a half minutes. But it would be even more astonishing if there was nothing at all across that wide expanse that separates me from the sun.

ARE ELECTRONS THE LUMINIFEROUS AETHER?

So what would the characteristics of this medium be? In order to answer that question we need to first specify which one. Waves can pass through a variety of substances. Visible light does not pass through some materials, but electromagnetic waves of other frequencies do pass through most things. When light is moving through air the medium is air, when it is moving through water the medium is water, when it is glass the medium is glass, and so forth.

But what would be the medium in outer space? Although people sometimes refer to it as 'empty space', or light moving 'in vacuo', outer space is not really a vacuum. Ironically enough, there is something called the interplanetary medium which fills the solar system. Beyond that there is the interstellar medium which exists between the star systems in a galaxy and begins where the interplanetary medium ends. There is even an intergalactic medium in the space between galaxies. The density of this material is quite low because it is extremely spread out, but it is there. As for where it comes from, one source is stars. The 'solar wind' is a continuous flow of charged particles from the sun that permeates the solar system. It is estimated that every second a million tons of matter is blown out of the sun in every direction, and it would be similar for the other stars.

Light could possibly be moving through some kind of plasma or plasma-like substance in outer space. I say ‘plasma-like’ because it may not be a true plasma. Plasma is an ionized gas in which electrons are stripped away from the nuclei of atoms creating free electrons and positively charged ions. This could easily be the case in outer space because plasmas are most likely to occur at low pressure and very high temperatures. There would be low pressure pretty much everywhere in outer space and high temperatures would exist around stars. It could be partially ionized hydrogen, helium, and other very light elements that are cyclically ionized by the heat when they are near stars or when they are first emitted by stars.

One reason that this possibility is a contender is that plasmas are extremely good conductors of electricity. This, along with the very low density that exists in outer space is possibly what allows light to move at its fastest speed. But when the material becomes more dense, with larger positively charged atomic nuclei that are more densely packed and are thus more likely to hold on to their electrons, and to keep them from moving to different energy levels, there is greater resistance to the wave which is why it slows it down and more of the energy is absorbed.

The fact that earth has a magnetic field around it suggests that there could be an electric field as well. We know that the upper atmosphere contains a high concentration of ions and free electrons in the ionosphere and the magnetosphere. Perhaps outer space has some similar characteristics. There could be a partially ionized plasma that fills outer space and is the medium that we are searching for.

However there is also another possibility. What if there are actually a lot more free electrons (and other leptons) in the universe than what is currently believed? I think we have a tendency to assume that the number of electrons that exist must equal the number of protons that exist because they balance each other out in stable atoms and molecules. Even in plasmas the overall electric charge is relatively neutral because there are roughly the same number of electrons as protons they are just not bonded together as they are in other substances. But suppose that there was another type of balance: what if the total mass of electrons and other leptons is roughly equal to the amount of mass that is in the form of quarks,[41] which make up protons and neutrons?

A proton is 1843 times the mass of an electron. If only one electron offsets the charge of one proton then the electron must have a much greater charge relative to its mass. I suppose that could be true, but what if it was actually a cluster of electrons which congregate around the positively charged nucleus in certain regions, and it is this cluster which has the combined charge that offsets the charge of the nucleus? It may not necessarily be 1843 electrons for each proton,

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[41] As of right now, quarks are only theoretical. I am assuming that experimental evidence for them is correct because at this point I do not know of any reasons to not trust it, but I do not actually know whether they are real or not.

but the charge produced by the cloud of electrons would collectively offset the charge of the nucleus. The atom would continue to accumulate electrons in its orbitals until the charges offset. Once it is balanced, or close to being balanced relative to what is around it, the repulsive force of the electrons would be stronger than the attraction to the nucleus for free electrons so no more of them are captured in the orbitals. Another way this can happen is when atoms and molecules share electrons, which can make them both more stable, such as two hydrogen atoms being bonded together. This type of thing is sometimes observed in nature because once it does occur it tends to persist longer because of the relative stability. However, even if the atoms and molecules are stable the interactions would still be dynamic because like charges repel, so the electrons would tend to be somewhat spread out and when they got too close to each other they would repel. There would be a constant interplay between the forces holding the atom together and those that would separate the particles, especially as it interacts with other atoms and other particles such as free electrons and muons bombarding it.

Current models for the composition of atoms use a ‘cloud model’ in which the location of the electron is shown as a cloud of points that represent a probability distribution of where the electron is most likely to be found. According to the Copenhagen Interpretation of quantum mechanics, until it is observed the electron is a wave, so it is spread out in all of those places at once until it is observed. The act of observing it collapses the wave function into a particle at a particular location. Note that it is never observed as a wave, it is just inferred that it is a wave when not observed based upon other evidence.[42]

But what if the ‘cloud model’ was not thought of as a probability distribution of where the electron might be found, but instead as a cluster of electrons that all together have a charge that balances out the nucleus? What if those models were interpreted to be showing where the highest concentrations of actual electrons are located inside the atom? That is similar to what I imagine.

If the nucleus was accelerated rapidly this cluster of electrons around it could be deformed somewhat. (Contrary to what Lorentz thought, it would probably be a bit stretched out.) The attractive forces holding the atom together (magnetic force of opposite charges attracting one another) would cause most of the electrons to move with the nucleus but they could be more spread out and it might lose a few electrons. It would be colliding with or at least affected by other particles and of course affecting them as well, which would cause more interactions. Once the nucleus slowed down or stopped the atom would probably reconstitute into basically the same form as before, or one that is similar. Larger masses with more atomic nuclei grouped together and shared electrons would be less likely to do this, but it could happen with a single atom.

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[42] I think this is rather convenient in explaining why the particle is always observed as a particle and never as a wave: every time you observe it in any way it is said to collapse the wave function, so of course you would never be able to observe it as a wave. That seems a little too convenient, to the point of being ad hoc.

The particle does not turn into a wave when you are not observing it and then collapse back into a particle when you do observe it, as the Copenhagen Interpretation asserts. We have observed particles, and we have evidence of waves; that does not necessarily mean that matter or light has a dual nature as both a particle and a wave. Scientists are working under the assumption that there is only the particle in empty space so when they observe evidence of waves they assume that the waves must be that particle. But I believe that what is really happening is that waves are being created by moving particles, and the 'atomic gun' or whatever is the force that causes the particle's motion in the experiment, in a sea of other particles. The reason that the particle is never observed as a wave is because it never is a wave. Moving particles create waves and are affected by other waves just like a swimmer in a pool of water. This is the primary cause of the 'wave behavior' of particles in motion.

Let's talk about Thomas Young's famous two slit experiment. The primary takeaway from it is that light diffracts and it creates an interference pattern, which is evidence that light is a wave. The surprising thing is that the experiment has also been done with single atoms fired one at a time and a similar interference pattern emerges. This is thought to show that the atom turns into a wave and passes through both slits at once and then it interferes with itself (as a wave) on the other side of the barrier, proving that the atom is at that point a wave.[43] But suppose that there is a medium of smaller particles that has not been accounted for. (Or this may even be the case for air if the experiments are not being conducted in a container without air.) What is showing up on the screen on the other side may not even be the same atom that was fired from the apparatus. In many cases it is probably not the same atom, but even if that particular atom did make it through one of the slits how it would bounce off and be deflected by the particles that make up the medium would be impossible for us to predict, which is why analyzing it in terms of probability works best. If a similar experiment was done underwater, firing a .50 caliber bullet from a special apparatus designed for it, that would create water waves and after the water passed through the two slits the water waves would create an interference pattern on the other side of the barrier. It is not that the bullet turns into a wave and passes through both slits simultaneously, it (along with the apparatus that fired it) just creates waves (or a disturbance) in the water. If the act of observing does change things at the quantum level it is probably because light itself is a disturbance, so any time light is focused on a quantum event it would be like water waves hitting something larger, such as a stick, and the waves would affect it.

Obviously what I am saying is quite speculative. But I think it is pretty likely that there could be a lot more electrons than is currently believed. Just suppose for a moment that in terms of total

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[43] See the first chapter of *Quantum A Guide for the Perplexed*, called 'Nature's Conjuring Trick'. Also, Chad Orzel, in *How to Teach Quantum Mechanics to Your Dog* says:

> Everything we have talked about so far has been a one-particle phenomenon. Most of the experiments need to be repeated many times to see the effects, using different individual particles prepared the same way, but at a fundamental level, all the interference, diffraction, and measurement effects we've talked about work with one particle at a time. Each particle in an interference experiment can be thought of as interfering with itself, and measurement phenomena like the quantum Zeno effect involve the sate of a single particle.

mass, leptons, of which electrons are one type, roughly equaled quarks, which make up the protons and neutrons.[44] That would leave a lot of leptons that are unaccounted for. I don't know if there is necessarily is an equal amount of each in terms of mass, but it is something to consider. There could be even more leptons than quarks in terms of mass.

I think lepton particles are the medium for light in outer space. Leptons include electrons but there are also muons, neutrinos, tau particles, and a few more. These particles would likely be found in greatest abundance in the wide expanse of outer space because they are not affected by gravity, which causes the quarks to clump together, unless they are bonded with quarks. Like most naturally formed mediums it would be a mixture. Just as air and ocean water are mixtures of many different types of atoms and molecules, there would be many types of particles, in some cases even positively charged ions of hydrogen and so forth, but it would be mostly composed of lepton particles. One could think of masses that are composed of quarks bonded with electrons as floating in a sea of lepton particles, like a giant soup with more dense items mixed in throughout. Even within and around the atoms of matter that we are familiar with there would not be empty space, there would be lepton particles.

Matter tends to clump together, such as stars and planets, because of the gravitational force, where protons and neutrons (quarks) are most prevalent, but balanced with some electrons. Outer space is where free electrons and other leptons would be found most, since they are not really influenced by gravity, but it is still interspersed with some lighter atoms and molecules like hydrogen and helium, in some cases ionized. Because these particles have such a small mass they are easily accelerated so they would achieve escape velocity from planets more easily. The particles that are not bonded to atomic nuclei would not be affected by the gravitational force.

Light waves and other forms of electromagnetic radiation would be a disturbance of these lepton particles, primarily free electrons. The speed of light, c, is the fastest speed that the wave moves because in outer space it is unencumbered by quarks holding on to the electrons, or at least there are not significant numbers of them to really slow it down.

Electrons would also be the medium for electromagnetic waves inside of matter that is more dense, meaning the electrons that are bonded with atomic nuclei. Once scientists in the nineteenth century realized that light was a wave they naturally concluded, and correctly so, that there must be some sort of medium that light was moving through. This they called 'ether' or 'aether', which was a term that Aristotle had used to describe a fifth element that made up the heavens. (I will use the latter spelling to distinguish it from the chemical compound known as 'ether'.) These scientists did many experiments to try to discover and prove that the luminiferous aether existed, but they were not able to detect it. Because of that Einstein concluded that it must not exist, or at least he did not think that it was needed. I do not want to get sidetracked with a

[44] An example of this type of balance is that hydrogen is the most common element in the universe by a wide margin, and has no neutrons. But in many other elements there are a lot more neutrons than protons. It is an asymmetrical arrangement, but there is balance.

long discussion and critique of these experiments but I will just say that I do not think that they were conclusive, and in some cases I am not even sure about the design and what the scientists were hoping to prove with the experiment. Anyway, the aether was thought to be a very rarefied and highly elastic substance, presumably composed of much smaller particles than ordinary matter, which permeated all space, including the interstices between the particles of ordinary matter, and it was the vibrations of this medium that created light waves and other electromagnetic radiation. This is actually fairly accurate, but we do not need to look for much smaller as yet undiscovered particles; undiscovered particles may exist, of course, but we could also ask ourselves which of the particles that are already known, and are a component of ordinary matter, that could have such a role. The answer is obvious when you think about it: it's the electrons.

I believe that electrons (at least primarily) are the 'aether' that nineteenth century scientists were looking for. I say that because electrons are obviously related to electricity, in fact the movement of electrons is what electricity is essentially. If electricity is the result of electrons moving through a wire then it makes sense that an electric wave would also be the result of the movement of electrons. Secondly, electrons are components of ordinary matter, which explains why electromagnetic radiation can move through matter such as glass and water. In that sense, I suppose the 'aether' could be said to permeate all matter, but we do not need to suppose that there is some other substance, it is just part of what composes all matter.

Muons are known to have a role in cosmic radiation, and they do also penetrate ordinary matter. We don't really know as much about tau particles and neutrinos; the latter does not seem to interact with ordinary matter very much, but because of that it could be in greater abundance in outer space. Other lepton particles such as these could also be a factor in addition to electrons.

Maybe the reason that atoms vibrate and electrons move around the atom is because the atom is constantly being bombarded by other particles. (Whenever there is movement of particles it will cause collisions and displacements of other particles.) An imbalance in the number of protons and electrons may help to explain the instability and dynamism that we see in the universe. If everything was perfectly balanced one would think that over the course of billions of years most matter would eventually be in stable electrically neutral forms. If nothing else acted upon them to break those bonds they would just stay like that forever. Rather than entropy there would be a tendency toward stability over time. But if these leptons, including free electrons, are easily accelerated to high speed because of their small mass and the fact that gravity has little to no effect on them, and they are constantly bombarding otherwise stable atoms and molecules, moving electrons from orbital to orbital or even pushing some electrons out altogether so that the atom is unbalanced and then attracting other neighboring electrons, then it seems as though a system like that would be far more dynamic, which is, of course, what we observe in nature.

We tend to think of atoms as having definite boundaries because they are thought to exist in empty space. Each atom floats around in the void, only occasionally coming into contact with the outside edges of other atoms before being repelled. But I imagine it to be more like a mist of electrons[45] everywhere except for a few regions within the atom which are between the orbitals. These areas could be caused by the magnetic charge of the nucleus. Whereas without a positively charged nucleus the electrons would be spread out pretty much evenly, the nucleus attracts more electrons into certain regions around it than there would otherwise be so it leaves open other regions, like the crest and the trough of a wave. Because there are more electrons in that region than there would be ordinarily it creates a stronger net repulsive force to other electrons in the region nearby, between these orbitals, as like charges repel. Although electrons do move across those regions if propelled with enough force they do not tend to stay there for long. Electrons in the outer energy levels are attracted to the nucleus but not strongly enough to cross these regions unless some other force acts on them. In the first energy level their attraction to the nucleus would ordinarily be arrested by the repulsive force of the electrons that compose the neutrons and perhaps also simply from getting too close to other electrons in the first energy level. (The first orbital has a fairly small diameter compared to other orbitals which means that the electrons are fairly close to each other even if they are on opposite sides of the nucleus.) In some instances electrons could be absorbed or captured by the nucleus if a collision or repulsion of other particles drives them into the nucleus or into an orbital. Similarly, electrons and other particles can be released by the nucleus when there are collisions with other particles, or repulsion from like charges coming near each other, which could disrupt the electrons in other orbitals and even push some of them out of the atom entirely, which would in turn disrupt other atoms as well.

If you have ever seen a picture of something being dropped into a still pool of water with the resulting waves spreading out from the center, that is how I imagine it to look except that it would be three dimensional rather than two dimensional. Each positively charged nucleus causes distortions in the electron mist, which is all around it, that would look almost like a three dimensional wave that has been frozen in time, with its crests and troughs essentially frozen in place around the nucleus because the magnetic force holds them in place.

This would be a very dynamic system. A moving particle will move other particles around it, and since they are everywhere that creates a lot of movement. This causes phenomena such as light and heat, sound, shock waves, etc. Fast moving particles would create a lot of disruption to the particles around them, and the motion would appear to an observer to be erratic and unpredictable. The particle's path will be altered dramatically by collisions with other particles or even by being drawn off course because of the magnetic force, either by attraction or repulsion. We cannot even predict the path of a single air molecule, let alone an electron. But we can predict pretty accurately what the majority of air molecules will do, and so also with subatomic particles. I don't think that it is inherently random, we just don't have enough information to

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[45] If there were electrons all around the atom in addition to the orbitals it would be very hard to track any individual electron. You could only really give a statistical analysis because its motion would just be too unpredictable because of how other particles affect its motion, and perhaps there are frequently electrons entering and leaving the orbitals, one replacing another and so forth. It is not the case that an electron is in all of those places at once, it is that there are a lot more electrons than currently believed and electrons are likely to be in those regions at any given point in time, though one could not track any particular electron accurately.

accurately predict how an individual particle will interact with the others. We have only been able to observe and study this world for less than a hundred years. We are far more familiar with classical mechanics. I am optimistic that in time the quantum realm will eventually make more sense.

There is one question that has given me pause while considering potential objections: If there is a medium in outer space then wouldn't the planets eventually slow down in their orbits because of resistance? The particles would be much smaller than the molecules that make up air, so there should be a lot less resistance than with air, but still, it seems like over the course of millions of years celestial bodies would be slowing down at least a little bit, even if the resistance was very small. Because of this concern I even briefly considered the possibility that the medium for light might not be material. I am not exactly sure how that would work, but I wondered if maybe the medium could be the cosmic microwave background radiation (CMB for short). Maybe light could be a disturbance (wave) or a vibration in that energy field. The CMB does permeate the universe so I thought that it could possibly be the 'aether' and the fact that it is not material would account for why it was not detected in the 19th century experiments. But there are some problems with this. Once again I am not sure how a nonmaterial medium would work or whether that is even possible. The cosmic background radiation is itself radiation, and radiation comes in the form of waves. Could there be a wave (light), of, or within other waves (radiation)? I don't know if that makes any sense.

However, my concern was eventually resolved because I stumbled upon some information which suggests, in my opinion, that perhaps there is some resistance in outer space after all that does eventually slow masses down, although it is by an incredibly small amount. The source of this information is surprising and I acknowledge that I am interpreting the data in a radically different way than the scientists are. I actually found it in a Wikipedia article on 'Gravitational Waves'. Gravitational waves are believed to be waves in space-time which are created by large masses. Generally the disturbances are very small and come from very far away, but they are believed to exist.

Obviously I don't believe that gravitational waves really do occur in space-time, as space and time are not material substances, and the gravitational force is not a wave. But here is the relevant part of article:

> Gravitational waves carry energy away from their sources and, in the case of orbiting bodies, this is associated with an in-spiral or decrease in orbit. Imagine for example a simple system of two masses – such as the Earth–Sun system – moving slowly compared to the speed of light in circular orbits. Assume that these two masses orbit each other in a circular orbit in the x–y plane. To a good approximation, the masses follow simple Keplerian orbits. However, such an orbit represents a changing quadrupole moment. That is, the system will give off gravitational waves.
>
> In theory, the loss of energy through gravitational radiation could eventually drop the Earth into the Sun. However, the total energy of the Earth orbiting the Sun (kinetic energy + gravitational potential energy) is about 1.14×10^{36} joules of which only 200 watts (joules per second) is lost through gravitational radiation,

leading to a decay in the orbit by about 1×10^{-15} meters per day or roughly the diameter of a proton. At this rate, it would take the Earth approximately 1×10^{13} times more than the current age of the universe to spiral onto the Sun. This estimate overlooks the decrease in r over time, but the majority of the time the bodies are far apart and only radiating slowly, so the difference is unimportant in this example.

Okay, so here is what we know: Celestial bodies in orbit experience orbital decay. This is currently attributed to a loss in energy because of gravitational waves that are created in space-time, but what if it is actually from the resistance of the medium that is in outer space? A slight amount of orbital decay is exactly what I would have predicted if in fact there is a material substance in outer space rather than a vacuum.

Orbital decay is caused by the earth's atmosphere for bodies that orbit the earth in a much more extreme way, which is to be expected because the particles that make up the earth's atmosphere are much larger and the orbiting bodies are much smaller than planets and thus have less momentum. In outer space there is a very small amount of slowing and resulting orbital decay by comparison, but it is not zero. Since I do not believe there is any such thing as gravitational waves[46] I attribute this slowing and the resulting orbital decay to the medium. Laws of motion such as those of Kepler and Newton are idealized representations. They did not know that there was a material medium in space and its results are negligible for most calculations. Newton's first law of motion is still true, but we have to account for the fact that in the actual world a body in motion would not stay in motion indefinitely because of the resistance of the medium, which is an outside force acting upon the body, even if no other force was acting upon it. There would rarely, if ever be an actual case in which no force at all is acting on a body to accelerate it in some way. It is like the mythical frictionless plane. However the idealized laws are a good approximation of reality (or reality is a good approximation of them) because the amount of resistance is small.

The CMB is probably caused by the motion of the particles that make up this material medium, but it is not itself the medium. I wonder if perhaps the radiation that is being detected would be similar to detecting various waves within a large body of water. The waves are a movement of, or disturbance of the particles that make up the water, and this would be similar. Light waves would be like a particular wave within the body of water but there would be many others of various types.

Some scientists who believed in the aether thought that it would be at rest, so they thought that one could find the absolute motion of an object by judging its motion relative to the aether.[47] I believe that is misguided. The air has air currents and wind, and the ocean has many tides, currents, and waves; it is certainly not true that these mediums are motionless, or that they

[46] However there would be waves in the medium that come from the motion of objects as well as events such as supernovas, which would create waves just like an explosion on earth does. Perhaps this is what is being detected.

[47] One can see where Einstein and Poincaré got some of their ideas, in part as a rejection of this view after the Michelson-Morley experiment.

represent some sort of fixed or absolute reference point. In fact we know they move along with the rest of planet earth in its orbit. There is no reason to suppose that the medium in outer space would be motionless or represent an absolute state of rest any more than anything else. You could measure the speed of an airplane relative to the air that it is moving through, but that would not necessarily be any more ‘absolute’ than measuring the plane’s motion relative to a location on the ground or relative to anything else. The medium moves in part because objects are moving through it, but also just because it is a dynamic system.

One last thing on this is that it may have occurred to you, as it did to me, that perhaps the resistance of this medium could at least somewhat account for the purported length contraction of Special Relativity which scientists swear that there is a lot of empirical evidence for. A volleyball and a bowling ball are about the same size, however the former is elastic and filled with air whereas the latter is not very elastic at all. If we imagine a volleyball accelerated up to a speed approaching the speed of light it seems possible that it could become distorted even in outer space because of the resistance of the medium. (Though probably not by much.) If one watches a basketball or volleyball being dribbled in slow motion it flattens out against the floor before bouncing back up. Perhaps its shape could be distorted by the resistance of a medium at very high speeds. However this would not really be length contraction as Einstein and others described it because the ball is not contracted, its shape would simply be distorted. It bulges out in the middle as it flattens in the direction of motion. Also, objects that are made of different substances would be distorted by different amounts, which is contrary to what Einstein claimed. For example the bowling ball or a solid rock would be distorted very little, if at all, in comparison to a basketball or volleyball. Also, the cause of the distortion would obviously be much different than what the cause is purported to be for length contraction. Finally, it would not be relative and there would be no time dilation. Thus, if this does happen it would only be coincidental that it seems to have a slight similarity to length contraction.

THE TRANSMISSION OF LIGHT

Before proceeding to a discussion of how light is transmitted I think it would be helpful to discuss sound waves. Obviously there are some differences between light waves and sound waves but I think there are also some important similarities.

If either prong of a tuning fork is struck both prongs will move inward and then outward very rapidly and will repeat this motion for a long time. One should consider why the second prong moves. Before the original prong is struck it occupies what could be called a rest position. After being struck the prong is displaced, let’s say to the right. It then moves to the left, past the rest position, and then to the right again. This sequence repeats many times. The sideways oscillation of the prong causes movement in the air molecules around it, which causes the other prong to move even if it was never struck directly.

How does this cause sound? The fundamental fact about the behavior of air that is important here is that air pressure seeks to become uniform everywhere. This means that if the air pressure becomes higher in one place for any reason the air will spread out from that place into neighboring regions where the pressure is lower. As the prong moves to the right it pushes the molecules of air that are near it to the right and thus crowds them into a place occupied by other molecules. The pressure becomes high in this area, and since the molecules of air cannot move to the left because the prong is there they will move off to the right (and in other directions that are available) in order to equalize the pressure. But this motion means that the crowding now occurs a little farther away from the tuning fork, and again, to equalize the pressure, the molecules move farther to the right. The process continues, and the crowding, or condensation, moves off to the right (and in other directions that are available).

The prong, having moved as far to the right as it can, will now move back not only to its rest position but farther to the left. This motion leaves an area of low pressure - the space that the prong had occupied - so the molecules of air that are bunched up on the right move into this empty space. Molecules still farther to the right also move to the left (as well as to the right for some of them) because there is now less pressure in that area. Thus a state of low pressure, or rarefaction, moves to the right as the air molecules move to the left to equalize the pressure in their neighborhood. With each successive vibration of the prong, a condensation and rarefaction move off to the right. (And other directions, but to keep things simple we will focus on the wave moving to the right.) This is a wave in the air molecules and it causes the other prong to vibrate as well.

The action is complicated because air is composed of billions of molecules and they do not all behave in the same way. But there is an average effect. It is convenient to speak of a series of typical molecules to the right of the prong which represent the average behavior of the entire collection. If we consider the action of any one typical molecule, what it does is move to the right when the prong moves to the right. When the prong moves to the left the typical molecule will also move to the left because the pressure has been lowered in that direction. Like the prong, it will move past its rest position and continue to the left. Then, as the prong moves to the right, the molecule will be pushed to the right again, past its rest position, and the process will continue. In other words, oscillations of the prong cause oscillations in the air molecules that are around it. Typical air molecules that are farther away from the prong will behave like the typical molecules that are near it except that their reactions will be slightly more delayed since condensations and rarefactions reach them a little later.

The sound wave which moves from the prong to a person’s ear consists of the series of condensations and rarefactions induced by the prong’s motion. Each air molecule merely oscillates about its rest position (no single air molecule travels with the wave as a projectile), but in doing so it produces the increase and reduction of pressure which cause the neighboring molecules to oscillate.

The nature of the sound wave may perhaps be made clearer by comparing it with a water wave. If the end of a stick is quickly moved back and forth in still water a series of waves will spread out from the end of the stick. However, the individual water molecules do not move out with the wave. Each water molecule oscillates about its original position, but the increase and decrease in pressure which the stick creates cause the molecules farther away to duplicate the motion of the molecules near the stick.[48]

Mechanical vibrations create waves in matter and we can detect some of these as sound. When someone speaks, or sings, or screams, or we hear some other kind of noise, what is really happening is that the air molecules are wiggling back and forth hundreds of times per second, causing the pressure to be low in some places and high in others, or in other words it creates waves in the air. We hear different wavelengths as sounds of different pitch. Some of the vibrations are absorbed, but the absorption by the atmosphere depends on the wavelength. The longer the wavelength the less sound that is absorbed by a given thickness of air. (Foghorn blasts are in the bass so that they will travel as far as possible.) The shorter the wavelength the more efficient the reflection. Bats squeak with very high frequencies of 130,000 cycles per second, which is reflected very efficiently, and this is why they can use those reflections to navigate.

It is not hard to imagine how being able to detect sound waves could be beneficial to an organism from an evolutionary standpoint. Anything that helps the organism to detect changes in its environment and to detect the presence of other organisms that could be predators or potential mates/mating rivals would be helpful. The ear is a structure that has been adapted over many millions of years to act as a receiver to detect these waves. But it does not detect all of them, and different animals have different capabilities for what they can detect because what would help them to survive and reproduce most effectively would vary from species to species and also depend somewhat on the environment. In some cases other evolutionary traits would take priority.

Now let’s connect this discussion to light and visual perception. Sound is considered a compression wave. It is sort of like one group of people pushing another group from the side, which in turn causes them to run into others, and so on. Light, on the other hand, is thought to be a transverse wave. In a transverse wave the medium moves at right angles to the direction that the wave travels. This is what happens with water waves as the individual water molecules move up and down with the crests and troughs of the wave. However, I wonder if perhaps the electrical part of the ‘electromagnetic wave’ is a compression wave. Electrons would be oscillating back and forth around their rest position as they are crowded into areas of higher pressure then repelled by other electrons back into areas of lower pressure, similar to what happens with air molecules in sound waves. This causes the magnetic force, which could be thought of as a transverse wave. When an electrical charge moves through a wire a magnetic field is created

[48] I got most of this information on sound from *Mathematics for the Nonmathematician,* by Morris Kline, p. 438-441.

around the wire which is at roughly a 90 degree angle to the length of the wire, similar to a transverse wave. Moving charged particles are known to generate magnetic fields.

Scientists lump it all together as ‘electromagnetic radiation’ because there is such a push to unite everything into one, and the current model says that the electric wave generates the magnetic wave and vice versa in an alternating pattern of transverse waves at a 90 degree angle to each other. But the magnetic force might not even be a wave. In fact, it probably is not. The magnetism of natural magnets, such as some rocks composed of iron, does not appear to be due to waves; this also shows that the magnetic force can exist independently of electric waves. The two forces are related and often interconnected but they are not the same.

The electrons would probably rarely if ever actually collide with each other as air or water molecules do. Like charges repel, so this would be enough to move them if other electrons got too close, and it would cause them to spread out and fill empty spaces when that is possible. This creates what could be described as a wrinkling or crumpling, a temporary concentration or bunching up of the electron medium in certain areas and a rarefaction in other regions.

Just like air molecules the electrons would naturally spread out and be relatively evenly disbursed ordinarily. If some event suddenly causes a condensation of them in that particular region of space they would naturally repel each other, which would cause some of them to move away from an area of high concentration to one of lower concentration. This is the electric wave, and this movement of charged particles also creates a magnetic field. It is the oscillations of the electrons that creates them both.

Often the same event will cause many types of waves in the surrounding environment. The same explosion can cause both shock waves and sound waves. An earthquake creates P waves and S waves at the same time. Incoherent light, which is what comes from the sun and standard light bulbs, is composed of light that is of many different wavelengths all jumbled together. This is because the particles of the medium are being moved in a multitude of ways.

The sun is creating all sorts of displacements to the particles in its surrounding environment which translates to waves of many different types. In the visual spectrum orange and yellow light have a longer wavelength than other colors because the particles are moving further but not as fast as they do when they produce blue or violet light. I assume that when it is undifferentiated light with the full color spectrum, as with ordinary sunlight, that means that some particles are being moved further than others (longer wavelength) and some are moving with greater frequency but not as far which creates waves of many colors simultaneously. Essentially it is a mixture of waves.

As far as why the sun produces light, as a body heats up there are more collisions of the particles and the electrons move to higher energy levels because they are being moved around with greater speed and force. Some electrons are knocked out of the atom’s orbitals entirely while others are pulled in from other atoms that have lost them (or just free electrons) and captured. Even the electrons that are not lost would be creating a disturbance in the electrons around them. Thus the disturbance and movement of electrons within the atoms that make up the sun cause a disturbance in the free electrons (and other leptons) that surround the sun. The waves that are created in these particles is light, along with other electric waves outside the visual spectrum.

When a body cools off it tends to be more stable, with the atoms and the electrons within the atoms moving at lower speeds. When this is the case the magnetic force is often strong enough to attract electrons from the surrounding environment into its orbitals. When the atom has orbitals that are as full as they can be it is relatively stable, though it is still bombarded by other particles. This is not always true, but bodies that are at cooler temperatures tend to absorb 'radiation' or the electric waves,[49] which in turn disturbs the electrons that are already there in the orbitals, creating more disruption or energy in the movement of those electrons, which we know as 'heat'. Bodies at higher temperatures are usually less stable in being able to hold on to their electrons, and the electrons within their atoms are moving more, and the atoms themselves are moving around more, which creates disturbances in the electrons that surround the body, so these would tend to, on average, give off 'radiation'. Thus heat flows in only one direction, from a state of high energy and movement to one of lower energy. If a hot or warm object is put into a freezer the heat will flow from the object to being diffused throughout the rest of the environment inside the freezer; if a cold object is put into a 500 degree oven the heat will flow from the surrounding environment into the object.

Let's compare what I have said to the way that light, and other forms of radiation, is currently believed to work. According to this view an electron gains energy by absorbing a photon which causes it to jump up to a higher orbital. The difference in energy between the two orbits will be equal to the energy of the absorbed photon. The 'excited' electron will shortly after spontaneously drop back down again by emitting a photon with the same energy. This process is called spontaneous emission and is said to be the way an electric light bulb works. The current flowing through a tungsten wire heats it up, causing the electrons in the tungsten atoms to gain energy and become excited to higher orbitals. When they drop down again, they emit photons over a wide spectrum of frequencies including those in the visible light range.[50]

There is no need to posit the existence of photons at all. We can just cut out the middle man and say that electrons from outside the atom move into the electron orbitals because of the wave, which disturbs the electrons that are already there, causing some of them to move to a higher orbital because they are accelerated to a higher speed, and in some cases they are kicked out of the atom completely and often replaced by a previously free electron. This would then cause the

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[49] If the orbitals are already full it may simply increase the frequency with which free electrons and electrons from other atoms are exchanged for the ones in the orbitals. This also would increase the heat simply because there is more movement and disruption of the particles.

[50] p. 219, *Quantum, a Guide for the Perplexed.* This description is based upon QED theory, or quantum electrodynamics.

newly free electron that was kicked out to perhaps move into the orbitals of a neighboring atom and the process repeats.

It is strange to me that it is believed that a photon is absorbed, which moves the electron to a higher energy level, and the electron then moves down to a lower orbital 'spontaneously' (as though that would happen without any cause) which then releases a photon of identical frequency to the one absorbed. Why couldn't it just be that the wave pushes some electrons into the atom's orbitals and/or disturbs electrons within the orbitals which then pushes some of those electrons out of the atom and/or disturbs neighboring electrons? That explanation is much cleaner. It is not photons that move electrons, it is other electrons. It is not photons that are emitted, the electric wave simply passes through the object (when that object is not the source of the radiation) which disturbs and causes the electrons within its atoms to oscillate and vibrate, much like free electrons do, which then causes the electrons on the other side of it (outside of the object) to oscillate, and the wave continues.

One of the main arguments for light having a particle nature comes from an experiment done in 1923 by Arthur Compton. In the experiment Compton shined X-rays (which are electric waves that have a higher frequency than visible light) on a block of graphite and found that the X-rays bounced off at a slightly lower frequency, which corresponds to a longer wavelength, than what they had originally. Shorter wavelengths have more energy and higher momentum, so this was interpreted to mean that individual photons were colliding with individual electrons in the graphite and some of their energy was lost as a result, similar to how when one pool ball hits another some of its momentum is lost. (The experiment is also used to show that photons have momentum, a claim which I have already discussed.) In other words it is particles bouncing off of each other, with the momentum of one (photon) being transferred to the other (electron). Compton measured the wavelength at many different angles and he found that the amount of momentum lost also depended on the angle at which the photon bounced off: a photon that only glanced off of an electron did not lose as much momentum while one that bounced almost straight back lost a lot,[51] which certainly does seem like particle behavior. But that does not mean that light (or X-rays) must be a stream of particles. It is the particles of the medium; electrons, moved by the wave, are bouncing off of other electrons. (The same could be said for the photoelectric effect.) They may not necessarily be colliding, at least in most cases, but they would repel. The particles of the graphite give way and move. That would cause the wave to lose some energy as it bounces off.

One way that light and sound waves differ is that sound waves travel faster when the medium is more dense and when it is at higher temperatures. Sound travels about 4.3 times faster in water than through air if both are at approximately room temperature and pressure. It also moves faster through elastic solids, such as lead (3.5 times faster than through air), gold (about 9.5 times faster) glass (13.2 times faster), and copper (about 13.5 times faster). This is because when the

[51] The information in this paragraph comes from both *Quantum A Guide for the Perplexed*, and *How to Teach Quantum Physics to Your Dog*.

molecules are more densely packed the compression of the material occurs more quickly. Also, when the molecules are bouncing around with greater frequency and taking up more volume, as happens when the material is heated, this also speeds it up, which is why sound travels faster through warm air than cold air. (Temperature also makes a difference in liquids and solids). In contrast, light does not seem to be affected by the temperature of the medium, and moving through denser material slows it down. Light moves a little bit slower through air than it does in outer space (where it moves at c), and only about .75c in water. Glass slows it down even more, at approximately .67c, and when it moves through diamond it is much slower at only about .41c.

What is the difference? Well, I think that light moves at its fastest speed in outer space because the medium is mostly composed of lepton particles that are not bonded with quarks. That means they are very easy for other lepton particles to move. It seems like when there are more quarks, and especially when the matter is more densely packed, that the electrons are more firmly held and this slows the wave down and absorbs some of the energy. Consider water for example. Water acts as a filter and blocks out more and more wavelengths of light at increasing depths. The least energetic wavelengths are stopped first. Red is the first to go. At even fairly shallow depths such as 3 feet everything looks green below the surface in a swimming pool. As the water gets deeper, say 10-12 feet, everything begins to look greenish blue. (An injured diver will see his blood as green.) It looks more blue at increasing depths. Finally even violet and ultraviolet light (the latter is not in the visual spectrum, but is radiation), which have the shortest wavelengths but also the most energy, decreases rapidly with greater depth and most of it is stopped at about 200 meters and everything looks black. (Light can penetrate as far as 1,000 meters into the ocean but not enough that you could really see.)[52] Light waves penetrate a long way into water, but eventually they are fully absorbed. By 'absorbed' I mean that the electrons in the water molecules no longer oscillate, hence the wave is stopped.

Light slows down more through water than air because water is more dense. The longer wavelengths, such as red and orange, are stopped first because electrons are more tightly bound to the nucleus when the matter is more dense so it takes a more energetic wave (faster more intense vibrations) to move the electrons. A shorter faster vibration of the electrons (shorter wavelength) tends to penetrate further into matter that is more dense. With heavy atoms and molecules that have a relatively large nucleus and especially if those atoms are densely packed the nuclei hold the electrons more strongly, so there tends to be less movement of the electrons than when the wave is moving through lighter materials. When the disturbance does not move the electrons out of the energy level that they are currently occupying only shorter wavelengths are continued and they may eventually stop as well.

Some form of electric waves penetrate most substances but even the high energy ones like X-rays and gamma rays hardly penetrate heavy elements such as lead (Pb) at all. I think this is

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[52] The source for this is the National Ocean Service. https://oceanservice.noaa.gov/facts/light_travel.html An additional source for some of this information is *Unsolved Mysteries of Science* by John Malone, as well as my own personal experience when it comes to how it looks underwater in a swimming pool.

because it does not disturb the electrons as much because they are bonded so strongly with the surrounding nuclei. There are a lot of protons in a relatively small volume of space. This makes it so that the electrons within those atoms are less likely to move from one energy level to another or for an atom to lose electrons. Thus lead (and some other dense substances) can absorb the energy of the electron wave without having its electrons changed much by it.

Light and electric waves of other frequencies are a displacement or disturbance of electrons just as water waves are a periodic disturbance of H_2O molecules (along with other particles in most bodies of water) or sound waves are a disturbance of the particles that make up the air.

Part IV
How the Scientific Community was Converted

HOW DID THIS HAPPEN?

Frankly, I don't see how the Theory of Relativity could possibly be true. There are so many logical inconsistencies and outright contradictions, and just the sheer implausibility of some of it makes me feel quite certain that it is not true. Yet at the time that I am writing this, literally every physicist at a major research university believes that Relativity, at least in its broad tenets, is correct. The scientific community as a whole has thought that for over a century now. How could so many highly intelligent capable people have gone so far wrong for so long? Why didn't scientists in Einstein's day (as well as today) recognize or take seriously the problems and inconsistencies in the theory that seem so blatantly obvious to me? I have pondered that question quite a bit. Obviously it is possible that I could be wrong. But if it is them, then how and why did it happen?

There are a few factors involved, I think. One is inattentional blindness. If one is directed to pay attention to something else it can cause him or her to miss or ignore important information because it is not deemed relevant. There is a viral video online in which the viewer is told to count the number of passes that a group of basketball players make in a given amount of time. In the background there is a person in a gorilla suit. I actually did notice it myself, but the video says that a large number of viewers completely miss that until after it is pointed out to them because they are so focused on counting the number of passes. Because they were told that the number of passes was the relevant concern they completely missed something that they would have definitely noticed otherwise.

This is one of the downsides of the scientific method. One proposes a hypothesis and then designs an experiment to either confirm or disprove that hypothesis, but having the hypothesis already in mind can potentially cause inattentional blindness. The researcher could become so focused on the hypothesis, particularly if she is emotionally and/or professionally invested in the results, that she ignores anomalies and other significant information that is present in the data. Her interpretation of the experimental results is often skewed by the hypothesis or theory that she is working under because she already believes the theory to be true and she is expecting and hoping for confirmation. I consider myself to be an empiricist, I believe that empirical evidence is the foundation for knowledge, but we have to acknowledge that sometimes researchers see in the data what they expect and want to see. One need only look at controversial issues such as gun control and the death penalty to see how much interpretation goes into empirical results. Both sides on each of these issues are absolutely convinced that the empirical data is in their favor. Each side has all sorts of statistics and data that they think proves their claim, but they both choose to interpret the data much differently. They point to different research results or simply interpret the same results differently. If it was really that obvious, or at least if human beings were willing to be more objective, then the data would have already proven what is true one way or the other a long time ago and there would be no argument. But humans are not like that, scientists included. Usually we have an agenda, a particular sentiment or feeling on an issue, often because of how we were raised or what those around us think, and then we try to make the data conform to our sentiment rather than the other way around. The data itself does not lie, but how the data should be interpreted is the tricky part, and the lens that researchers view that information through makes a huge difference in what interpretation they have of it. Interpretation is always theory-laden.

I will provide an example. Roger Penrose, in the introduction to my copy of *Relativity The Special and General Theory* reports that two scientists named R.V. Pound and G.A. Rebka performed an experiment in 1960 to test Relativity's prediction that time is slowed down in a stronger gravitational field. (At least that was one of the predictions; other sources that go into more detail regarding the methodology say that there were also other predictions which were equivalent.) They did this by comparing time rates at the bottom and at the top of a 22.5 meter tower. According to Penrose, they found that the rate at the top was greater by a proportion that would amount to one second in 30 million years. To help put that into perspective, there are 31,556,952 seconds in one year. (Based upon the Gregorian calendar in which there are 365.2425 days in a year.) Do you think, based upon these results, that they would have concluded that *time itself* moves slower at the bottom of the tower than at the top if they did not already believe in Relativity? I don't, because that is not the most natural conclusion to reach in order to explain such a small difference. If it had been reversed and the results for the experiment showed time to be moving slower at the top of the tower, or even if they found no difference, you can bet that they would not have concluded that the experiment disproved Relativity. They probably would not have even reported the results in that case. So if the results of an experiment conflict with the theory they ignore them and dismiss it as experimental error, or it is considered an unexplained anomaly but they would probably not be too troubled by it, but if the results are in the theory's favor then the experiment is considered irrefutable proof of the theory.

Any evidence that seems to be in favor of the consensus view is considered a confirmation while any evidence that goes against it is simply ignored or dismissed. It reminds me of how police detectives and prosecutors can get so locked on to one suspect that they become very tunnel-visioned and will not even consider any alternative explanations or theories after they have made up their minds. One study even found that examiners sometimes came to different conclusions about the same fingerprint if they were told the print had come from a suspect who had confessed to the crime or was in custody.[53] The good thing about having a hypothesis is that it gives you something to test; the bad thing is that the tests are usually designed to confirm the hypothesis and having that idea already in mind creates a bias that can taint the interpretation of the results.

Specialization is a factor as well. It could cause a researcher to miss the forest for the trees. Each scientific discipline has become very specialized, and many scientists do not feel qualified to talk about anything outside of their specialty. Something like Relativity is now simply taken for granted in all specialties that are in any way related to physics, so it is unlikely that it would be seriously challenged by anybody in those fields; they could easily lose their professional reputation if they did. Even most physicists, let alone scientists in other disciplines, would spend hardly any time at all pondering on the objections and counterexamples to Relativity, or possible alternative views. They might think about it a little bit if they are teaching undergraduates and have to find good ways of answering student questions, but they would not take objections very seriously. The scientific community is convinced that there has been undeniable empirical verification of the theory, so unless they read something to the contrary in a very well-respected research journal they don't take any arguments against it very seriously. They probably assume that the only way that the theory could be disproved is through experimentation, but the problem, as we discussed, is that experiments are theory-laden, and even when there are experimental results that are not in harmony with the theory the results are considered anomalies and scientists either ignore them or just brush it off as not being very important. Such results are not enough to cause a paradigm shift. There is not a paradigm shift until there is a new theory that convinces other leading scientists.

The efforts of most physicists today would go towards dark matter, or String Theory, or M-Theory, or how to unite Relativity with quantum mechanics, etc. For them Relativity has already been 'discovered'; they want to break new ground. Of course Relativity is incorporated into any new theory that they come up with, so it continues to be taken for granted. I think that it is unlikely that very much real progress will be made until this is corrected. They are building upon a faulty foundation. I doubt that dark matter and dark energy even exist, and I think that one reason they have not been able to unite quantum mechanics with Relativity is because Relativity's explanation of gravity is not correct. It would be more fruitful to simply abandon Relativity and create a theory of everything based upon quantum mechanics and classical Newtonian physics.

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[53] This is from a story in the July 2016 issue of *National Geographic* that discusses some of the problems with forensic analysis.

However, in doing so, they should not go too far beyond the experimental results. All of the various interpretations of quantum mechanics currently available make the faulty assumption that if things are a certain way at the quantum level then it must be the same way at the macro level because the macro level (meaning the world of objects that we are familiar with in our everyday experience) is composed of these quantum interactions. This is actually the informal fallacy of *composition* in which one erroneously assumes that the characteristics of individual parts of something will also be the characteristics of the whole.

We should not discount the experimental data that comes from quantum mechanics, but we also should not discount the fact that quantum effects are not observed with objects in our everyday experience. The various interpretations of quantum mechanics give different reasons for why this is the case, but they all assume that those effects do occur with larger objects and they simply try to explain why we do not observe them. They all seem to be forgetting one very obvious possibility: maybe the reason that quantum effects are not observed at the macro level is because they do not occur at the macro level. That is actually the most likely explanation. If we can observe quantum effects at the micro level through experiments then why wouldn't we be able to observe them at the macro level if in fact they really do take place at the macro level?

Einstein does deserve some credit for resisting some of the crazier aspects of how quantum mechanics was being interpreted by other scientists. Abraham Pais, one of Einstein's collaborators, reports: '. . . during one walk, Einstein suddenly stopped, turned to me, and asked whether I really believed that the moon exists only when I look at it.' This was in reference to the Copenhagen Interpretation which insists that everything has a wave function until it is observed, and then the act of observing it collapses the wave function. John Wheeler said: 'No one can forget how he [Einstein] expressed his discomfort about the role of the observer, "When a mouse observes, does that change the state of the universe?" '[54] It may seem like Einstein is attacking a straw man version of the Copenhagen argument in these quotes, but he isn't: that is really what they believe! According to the Copenhagen Interpretation the collapse of the wave function occurs with large objects such as the moon, and it is the act of observing in some way that causes it, as strange as that seems. There is no reason to suppose that large objects such as the moon have a wavelength and collapse into their current form when an observer looks at them, even if that is what happens to an individual particle. Personally, I am not convinced that is really what happens with individual particles either, but even if it did that wouldn't necessarily mean that it happens with a large collection of particles such as the moon. It is especially absurd to think that the act of observing is what collapses the wave function for large objects composed of many particles because most of those particles would not ever be observed. Are we to believe that 3-5% of the moon, or whatever percentage of the particles that are visible to us at any one time, exists in the particle state and the rest of them are in the wave state? If the wave function only collapses for a small number of the moon's particles because we cannot observe the vast majority of the particles that it is composed of, below the surface for instance, or on the other side facing

[54] These quotes were given in *Einstein for Everyone*, chapter 1.

away from us, then how would the moon as a whole ever have a collapsed wave function? It makes no sense. Suppose that no observer has ever observed the earth's mantle: does that mean that it is a wave and has existed in the wave state this entire time?

I believe that the quantum realm is a chaotic system, meaning that the behavior is so unpredictable as to appear random because of sensitivity to small changes in conditions (but it is not actually random, it is just not well understood currently because we have not been able to study it for very long) and that the gravitational force stabilizes the system and makes it more predictable. That is why larger objects composed of many particles do not behave the same way as an individual particle. At the quantum scale the gravitational force is negligible, but with larger masses we have things like the law of inertia. As you move out to larger scales it goes from being a chaotic system to one that is very stable and predictable. There are few things that are more reliable than astronomical events that involve huge masses like planets, moons, and stars. When the force of gravity is strong the motion of objects is very predictable.

I agree with Einstein that quantum events could not be fundamentally random because if they were then they would have to be uncaused. The quantum event happened, but there is no reason why, it just did. That's our explanation? I don't believe that there can be uncaused events, and if there is a physical cause for it then it would be possible to trace back the whole chain of causes that led to it if one had enough knowledge about the system to do so, and even to predict future events if one had all of the relevant information. The problem for us is that we do not have all of the information, which makes it appear chaotic, and we can only use probability to make sense of it, at least right now. But such things as 'superposition' are just an abstraction, not actual reality. A particle does not really exist in all possible states at once. Schrödinger's cat is alive or dead, not both at once, and that is true whether we have observed the cat or not. This is similar to Relativity in that it claims that there are no observer independent facts about the world, nothing is defined in an absolute sense, etc., which is silly. Werner Heisenberg claimed that the results of measurements were the *only* reality - that it made no sense to talk about where an electron was or what it was doing between measurements.[55] To me, *that* does not make sense. We are part of the world, and just like other animals, we have evolved with senses that help us to perceive it because that aided our survival and reproduction; our observations do not create reality, they only help us (in some instances) to detect what the reality is. This is Anti-Realism taken to the extreme. Einstein was right to question the role of the observer in the Copenhagen Interpretation.

The 'Many Worlds Interpretation' of quantum mechanics is even crazier than the Copenhagen Interpretation. According to the Many Worlds view there are an infinite number of universes and all possibilities are realized somewhere. This means that in some other universe I am the President of the United States. In another you are President of the United States. In another, dinosaurs never went extinct and a dinosaur is President of the United States, etc. According to this view the wave function does not collapse, instead, the universe as a whole has a wave

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[55] *How to Teach Quantum Physics to Your Dog*, p. 63. He probably believed that, and the uncertainty principle, because he thought that everything had a wave function, which is not true.

function that is constantly evolving and when a measurement is taken it splits into multiple realities where different outcomes are realized. We only see and have access to our particular piece of the wave function. These are taken to be actual events though that are just as real as the events taking place in our world. But if gravity is a stabilizing force and it transitions from a chaotic system to a non-chaotic one as there are more particles grouped together and at larger scales of measurement then there is no reason to suppose that quantum effects occur at all except at the quantum scale (if even there). The universe as a whole does not have a wave function, nor large objects such as the earth or the moon or even a person. There is no reason to posit the existence of other worlds because alternative macro level events would not occur (or at least would not be inevitably guaranteed to occur) because of quantum events. The chaos or apparent chaos is confined to the quantum level only, it does not necessarily cause chaos at the scale of macro events. Ockham's razor should be used to shave off those other universes. They are not needed.

If scientists really do believe that quantum effects occur with macro scale objects I wonder why they tend to be so skeptical of stories that perhaps could be attributed to quantum effects, such as spontaneous combustion, ghost stories, religious experiences or other miraculous phenomena, or alien encounters. It may be highly unlikely for any particular person to experience such things, because there is supposed to be a very low probability for most of these effects with larger objects, but it would be quite a bit more likely that some human at some time would have observed them if they really exist. If the odds of your hand going through a solid object such as a table are billions to one, but there are billions of people around and billions of tables, then at some point one would expect that it would be observed by somebody.

But I have to admit that I am also pretty skeptical of such stories. It seems far more likely that they are merely tall tales, lies, or misperceptions, and nothing of the kind has ever actually happened, or is likely to happen. If that is true then there is no reason to believe that quantum events happen at the macro level, as they would never be observed at the macro level.

Ever since the Theory of Relativity became popular there has been a movement in theoretical physics to embrace the absurd. I don't really understand it. Maybe the physicists started getting high together at their conferences. But even though they were high as hell they were still really smart, so then they created a bunch of math that was internally consistent and they thought that this math proved that the crazy ideas must actually be true.

The early 20th century is when physics lost its mind and it has not yet recovered. In fact it seems to have gotten worse with each new generation: The various interpretations of quantum mechanics are even crazier than Relativity, and both are put to shame by String Theory and/or M-theory. I guess the feeling is that these earlier theories seemed bizarre at first but they turned out to be true (it is believed), so maybe this new theory is as well and it just seems weird because it is very different from our everyday experience. I suppose that is possible, but we should always ask ourselves whether it is really the most reasonable and likely explanation. In many cases it is not. Are you seriously going to mock people for believing in the Trinity, or Noah's

Ark, or a literal interpretation of the Bible's creation story when you believe in the Many Worlds Interpretation? (Not to mention some of the other stuff that we talked about in previous sections, such as Relativistic time travel, and/or Relativistic black holes, etc.)

I think it is amusing that many scientists also look down on philosophers, feeling that their own version of philosophy (science is 'natural philosophy') is far more sensible and reasonable than what those crazy philosophers like Plato and Descartes and Berkeley were doing; after all, they have empirical evidence to back up what they say. But I have to say that some of the most bizarre ideas I have ever come across are in theoretical physics. I think even Plato and Berkeley would say that String Theory is some far out shit. Now the Pythagoreans would really like it, so there is that, but the Pythagoreans were a crazy cult, too. Yes, yes, I know, you assure me that the math is consistent. Well, Berkeley's theory is pretty logically consistent too. Showing that something is logically possible only means that it could be true, it does not prove that it actually is true, or even that there is more than a very small probability of it.

EINSTEIN'S CELEBRITY

Another factor that cannot be ignored is Einstein's popularity with the media and the general public. He was the Elvis of academia. Even other scientists became infatuated. It reminds me a little bit of the love affair that the public had with Michael Jordan in the 1990s. He was my hero as well when I was growing up. It is hard to identify exactly what there was about him that made him so likable, but he had something that really drew people in. No doubt some of it was his immense talent, but it was also his personality. He had an incredible amount of charisma. Einstein was like that in science. Nobody was better at being the lovable quirky genius, especially later in his life when he had the crazy hair. Reporters ate it up.

Maybe part of the appeal of Einstein was his rags to riches story. It gives the rest of us hope, I guess, if we are currently in rags. It would be like founding a company and becoming a famous tech billionaire; in some ways it may even be better, at least for an intellectual. The man was practically worshipped by nearly everybody. We would all hope that we could be as happy and successful in our own lives as he was in his, or at least that is how it seems.

Another example that is somewhat like this (although still not as much as Einstein) is Christiaan Barnard, the doctor that performed the first heart transplant in 1968. He was on the cover of *Time* magazine, met the President of the United States (skipping another surgery to do so and be on television because he seems to have cared a lot more about the fame than the actual work) and dated beautiful movie stars. The interesting thing is that Barnard was not necessarily a better doctor than others; in fact, in many ways he was not as good. There was another doctor at Stanford University named Norman Shumway who should have been the first to perform a heart transplant. He was definitely a lot more qualified. Barnard only beat him to it because Barnard was willing to perform the experimental surgery on a patient that was not very healthy and far from an ideal candidate; he did not treat that patient very well after the surgery either, trying to keep him alive for as long as possible not for the benefit of the patient but so that the surgery would be deemed a success; in other words, to boost his own ego. I feel a little bad for Shumway, who got credit from his peers, but not as much as he deserved from the media and the general public. Yet, if you look at pictures of the two men, it seems unlikely that Shumway would have become nearly as much of a celebrity as Barnard even if he had been first to perform the surgery. There would have been stories about him and some interviews probably, but it is unlikely that he would have been dating beautiful movie stars. (He probably would not have sought out fame as much as Barnard did either though.) It may not have been the case that the President would have invited him to the White House either.

Popularity is a funny thing. It is hard to pinpoint exactly why a person strikes a chord with the media and the public, but there is just something about them that a lot of people find really appealing, and no doubt that is true of Einstein in the twentieth century. He may very well be the most significant figure of the 20th century even though the theory is wrong.

It would have been very difficult for a physicist to give a strong critique of Einstein's theory in the 20th century. No well-respected physics journal or science publication would have even published it. Hell, they probably still wouldn't. I have thought about trying to submit some essays to science publications on things such as the Twin Paradox while working on this project but I finally realized that it was hopeless. They would not publish it if there was even an implication that Relativity is not correct, especially if it comes from someone who is essentially unknown. Isn't that somewhat ironic, though, since Einstein himself was basically unknown in 1905? You would think that they would be more inclined to take outsiders seriously because of that, but I don't think that is the case.

But even if the newspaper reporters and the general public were captivated by him, why were physicists willing to embrace this theory in the first place when it came from an unknown who couldn't even get a job in science? I think a really important factor in gaining acceptance in the scientific community was that Einstein had backers within that community that were well-respected. The foremost of these were Hendrik Lorentz and Max Planck. (Both eventually won the Nobel Prize.) This was really important because it gave Einstein credibility with other leading scientists early on, which, as an outsider, he would not have had otherwise. It also helped that he was espousing ideas that were already fairly well-accepted within the physics community, at least for Special Relativity. As has already been discussed, much of it was not original with him. A lot of it was derivative of the work of the well-respected Henri Poincaré, as well as Lorentz and others. The theory must have seemed familiar enough that some scientists felt comfortable with it, as in some cases it resembled their own research or the work of others that they respected, but it was still unique enough to be interesting to them.

We also cannot forget the British astronomer Arthur Eddington, who did as much to spread Einstein's ideas and convert others to them as Paul did in spreading Christianity. Even before conducting his famous experiment, Eddington exhorted colleagues at scientific conferences to embrace the theory and defended it against critiques. Having astronomers and mathematicians (who were interested in the non-Euclidean geometry of General Relativity) on board as well as physicists gave the theory growing momentum from 1905 to 1917. It was then that Eddington performed his experiment during an eclipse which was thought to empirically verify that Relativity was true.

Scientists in many different fields praised Einstein after Eddington's results and it made it into the newspapers with some fairly remarkable headlines. It seemed to really intrigue reporters and the general public that scientists were convinced that the theory was true yet hardly anybody at that time could actually understand it. When a writer said to Eddington that perhaps there were only three people in the world that really understood the theory Eddington quipped that he was not sure who the third person would be. All of this gave the impression that the theory must be so complex that it was impossible for anyone who was not an expert to understand it, and if it seemed wrong or counterintuitive that was just because you were not smart enough to get it. All of this greatly added to Einstein's mystique. It made everybody think that he must be so far beyond the rest of us in terms of intelligence that no one was even capable of understanding his theory unless they were really smart, let alone come up with it (or 'discover it') as he did. That had a tendency to kill any objections because nobody would want to be labeled as too dumb to get it. (Even today those who endorse Relativity tend to think that anyone who does not agree with it must be stupid and/or uneducated.) Everybody who was anybody in academia, whatever the subject, soon believed Relativity, and it was understood that you had better jump on board the train or you would be left behind.

What is remarkable about all of this is that if you actually look at Eddington's results they are really not that close to the theory's predictions.[56] But by that time the pump had been primed and the academic community was ready to accept the theory regardless of the actual results.

Here is how Eddington's results were supposed to have empirically confirmed Relativity: According to General Relativity the curvature of space-time that is caused by massive objects will divert the path even of light because that path is actually the shortest distance between two points if space-time is curved. So Einstein predicted that light would be bent around large objects such as the sun because of curved space-time. One way to test this would be to see if the stars appeared to change positions when the light coming from them was close to the sun. The problem is that the sun is so bright that we would not ordinarily be able to tell. Eddington's idea was to test it during an eclipse, which is what he did once he got the opportunity, and he did observe an apparent shift in the positions of the stars, but the actual results were not really very close to what Einstein had predicted. Still, everyone was ready to embrace the theory by that time, so scientists around the world congratulated Einstein on the results and it was picked up in the newspapers and became a big story.

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[56] Newton also predicted that light would bend around barriers but he had a different explanation for why. Thus Eddington did not just need to show that light was bending around the sun, he had to show that it was in accordance with what Relativity predicted rather than what Newton had predicted.

I do accept the empirical results that stars appear to have changed positions with an experiment like Eddington's, but I do not think it is because of curved space-time. Here is an alternative explanation for why that would be the case.

Let's assume that the sun is close to the horizon. Light from the sun streams out in all directions, but some rays will travel horizontally. Now suppose that we have a large body of water and an observer that is under the surface. Some of the light rays will enter the water at a very large angle of incidence. This means that there will be significant refraction. The observer that is underwater will see the sun as being located in a different place in the sky than where it is observed to be by an observer above the water because of this refraction. Suppose that the crew of a submarine did not know about refraction and for some reason they wanted to shoot at a light source above the surface, perhaps a distant lighthouse or something. If they are viewing the target from below the surface and they do not account for the refraction they would very likely miss because the target would actually be located in a different spot than where it would appear to be.

Light is also refracted to a lesser degree just within the atmosphere. Every day we see the sun where it is not. For about five minutes before what we consider to be sunset the sun is actually below the geometrical horizon and should therefore be invisible. But the rays of light from the sun curve toward the earth's surface as they travel in the earth's atmosphere. Not only does the observer 'see' the sun when he should not, but its apparent position is different than its true position.[57]

One can see that the general rule here is that as light moves through a denser medium it slows down and is refracted. There is a stark difference when it goes from air to water, but we see it within the atmosphere as well. As discussed in previous sections, the top of the atmosphere is much less dense than at sea level. Also as previously discussed, light slows down a little in air from how fast it goes in outer space. It seems reasonable to think that it must slow a little and be refracted as it goes from outer space to the upper atmosphere and then to a denser part of the atmosphere near sea level.

If we assume that light travels through a medium in outer space then the medium would probably be more dense right around the sun than in other areas of space. I don't mean that it would have more electrons (although I suppose that is possible) I am talking about other heavier particles. The sun is constantly spewing out many particles, we know that from the 'solar wind'. There would also be more particles that are composed of quarks in and around the corona than in other parts of space because they would be attracted by the sun's gravity. It is really the same principle as the earth's atmosphere: heavier more densely packed particles will be near the surface of the sun than in regions of space that are farther away from it. If the general principle is that light is slowed and refracted when moving through a denser medium then light that comes from other stars would be refracted when it moves through the area right around the sun; this would cause an observer during an eclipse, because the sun is right between the observer and those distant

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[57] *Mathematics for the Nonmathematician*, see p. 4 and 177-178.

stars, to see those stars in a different position than where they would appear to be when the observer is viewing them at other times, through a less dense medium, similar to how we see the sun as being in a different position than it really is at sunset. It is not caused by curved space-time, it is just refraction.[58]

Here is another important factor in why the theory gained such strong momentum: General Relativity would have been very exciting to intellectuals because they thought it could help them in their own research. Hermann Minkowski had already developed his four-dimensional space-time, which Einstein incorporated into Relativity, and Bernhard Riemann had not long before that developed non-Euclidian geometry, especially the geometry of curves. All of this math was initially thought of as interesting but not especially relevant for any real world applications, but now the claim was that it was actually the fundamental reality of the universe. That had to be very exciting for mathematicians and for physicists, whose stated goal was to provide a mathematical description of nature. Einstein and his mathematician friend Marcel Grossmann also used and further developed tensor calculus, which would have been on the cutting edge of new mathematical research at the time. Even in the humanities many wanted to use Relativity to bolster their own argument, whatever that happened to be. Once they believed that there had been empirical verification everybody wanted in on the hot new trend.

EINSTEIN'S LEGACY

Maybe you have gotten the feeling that I do not have much respect for Einstein or his work. It is actually a bit more complicated than that. I don't think that he is correct on most of it, and he did 'borrow' (to put it politely) a lot of the ideas from others without always giving them credit, especially Poincaré, which is not good. Maybe it does not matter too much who should be given credit for a mistaken idea, but it does still reflect somewhat negatively on Einstein personally. I imagine that when he was writing those papers in 1905 he probably never thought it would get as big as it eventually did. At that time he was probably focused on just trying to get an academic job.

I do agree with Einstein's sentiment about the Copenhagen Interpretation of quantum mechanics. I actually think one of his greatest contributions to science was to resist the Copenhagen Interpretation somewhat when he could have easily just given in to the pressure and simply enjoyed the adoration of others. (Ironically, most physicists have the exact opposite view: they think that Relativity is correct and that Einstein was losing his touch when he resisted the Copenhagen Interpretation.) A physicist of lesser standing might very well have been run out of

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[58] I have wondered why light seems to bend towards the center of mass in denser materials. Light is not a particle so it would not itself be attracted to masses by gravity, but I wonder if the light causes a disturbance of the particles of the medium and when they are heavier particles that have quarks perhaps the path that they take once they have been disturbed and are moving is slightly diverted by gravity which causes the light ray to curve or be diverted towards the center of mass somewhat more than when it is moving through lighter particles.

the profession, or at least severely marginalized for going against the consensus to that extent, but he was fearless in doing that. Einstein had a lot of independence of spirit, which is probably why he was able to come up with his own theory (well, sort of his own theory anyway) to begin with. One might think that it would be easier for somebody who was already so famous to do that, but in some ways it might have been harder because he had come from nothing and by then he had a lot to lose. It is one thing to take massive risks when you are an unknown patent clerk, it is another to risk it all once you have already made it big. Einstein was his own man, and I have to respect somebody who does not give in to the pressure. That takes guts.

However, I am quite certain that Relativity is not correct, and I have been wondering what will happen when scientists finally realize that. It probably won't happen because of me. I would like to believe that some scientists would eventually read this and be persuaded to think about the theory differently; it's possible, but realistically it is unlikely that anyone who is very influential within the scientific community will ever read it, and even if they did it is probably even less likely that they would be convinced by it. Perhaps it will be future generations that read it with the benefit of hindsight after the theory has already been disproved and/or replaced.

I wonder if maybe as technology advances the data will eventually become overwhelming and somebody, or a group of scientists that are influential, will finally realize that it just cannot be right and come up with another theory to replace it. To some extent the data against it is already building. The reason that scientists believe that dark matter exists is because if it didn't that would be a massive violation of the Relativity equations. Yet they are still looking for evidence of dark matter. There are other ways that the equations do not work as well, and other scientists have tried to update the theory to take into account these other factors. No one at this point seems to be seriously considering abandoning the theory because they do not currently have a different one that is thought to be better, but maybe one day they will.

It could also be that advances in technology will eventually disprove so much of Relativity, piece by piece, that they will finally have to reject it. But it would be embarrassing to admit an error of that magnitude, and very disconcerting to those who have dedicated their entire careers to studying it, so the scientific community may be unwilling to do that. For that reason I think this possibility is less likely. I am sure that a lot of scientists would be devastated by the news, but even if it was considered a setback it would actually help them in the long run in finally getting back on track.

However it happens (I am convinced that eventually it will), I wonder how the scientific community and historians will view Einstein afterwards. I could see it potentially flipping from one extreme to the other: it could go from everybody in his own day thinking of Einstein as the ultimate genius to later generations seeing him as a complete moron and/or a charlatan. Personally, I think either of those extremes would be an overreaction.

Einstein was obviously really smart. I am sure that he was smarter than I am in terms of IQ score and just sheer intellectual horsepower because I struggle with math and really abstract deductive reasoning. (Einstein got some help with the math from some of his associates, such as Grossmann, but still, it is really advanced math.) Any illusions that I might have ever had about being a genius because I can tell that the theory is wrong while others apparently cannot are quickly dissipated any time that I try to read Einstein's actual scientific papers (or any physics paper in a journal, really) and can barely even follow it. Part of the problem is being unfamiliar with the lingo; I can remember not having any idea what papers that used predicate logic symbols were talking about until I learned predicate logic, and it is probably the same with physics terms and the math that is employed in those papers. Still, I don't think anybody who is dumb could have written that. Now, was Einstein vastly more intelligent than his peers? Probably not. Physicists as a group tend to have a much higher IQ than average. I cannot think of any other group that would score higher. I am sure that Einstein was really intelligent, but probably not much more or less intelligent than his peers. It would be a mistake to overstate it or to understate it. He belonged in the group, I think, but he did not exceed them. There is no reason to be obsessed with his brain, as they seemed to be after he died, and to some extent still are. The main difference between Einstein and other physicists is that he was far more charismatic, so he could sell it better. I don't think he should be considered the quintessential genius, but let's not overreact, he was no dummy either.

Einstein was a theoretical physicist who had a theory that is wrong. That does not make him unique: most theoretical physicists who you have never heard of are highly intelligent people who have theories that are wrong. We should see Einstein no differently than them. Personally, I do not hold him in the same esteem as Aristotle, but that would be a good example of what I mean. Aristotle was a genius if there ever was one.[59] Just look at how much he advanced human understanding from where it was before him. But Aristotle was definitely wrong on a lot of

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[59] I read a philosophy essay once that questioned the 'greatness' of past philosophers that are considered the greatest of all time. The basic argument was that if you look at the work that today's philosophers are doing it is much more complex and difficult than what many of the famous philosophers of the past were doing. I have a couple of objections to this. First, complexity does not necessarily equal greatness. Sometimes great ideas are actually pretty simple. Darwin's Theory of Evolution is based upon a fairly simple idea, but it was still really important. Secondly, today we are standing on the shoulders of giants. Aristotle's idea of gravity seems pretty simplistic, but not very many of us would do any better based upon the information that he had available to him at the time. One of the actual examples used in the essay was to say that formal logic has advanced so far that Aristotle might not even be able to understand it let alone contribute to it if he lived today. I am not sure that is really true, but even if it is, you have to account for the fact that all of the people today have the advantage of being able to learn from everyone that came before them and that greatly speeds up their own progress. Could the logicians that live today have invented categorical logic entirely from scratch as it seems Aristotle did? I have a version of categorical logic myself that I think is an improvement on Aristotle's version but I know that I could never have just invented it all entirely on my own. The only way I was able to do it is to learn his system, as well as others, and then tweak it and adjust it here and there. The fact that Immanuel Kant didn't think that Aristotle's logic could be improved upon at all over 2,000 years later shows that it was a pretty good system. I believe that what makes a great thinker great is to look at what came before him and then look at the contribution that he made. If that represents a large step forward then that is a real accomplishment. Today's computer systems have advanced far beyond anything created by Alan Turing, but we likely would not have any of it, or at least not until much later, without Alan Turing. That is what makes him great, and someone worth remembering.

things. The fact that a theory is wrong does not necessarily mean that the person advancing it is not intelligent. It could be that they do not have all the information or correct information, and/or they are making faulty assumptions which lead to incorrect premises. In the case of Einstein, some of his conclusions do follow from his premises, I just don't agree with a lot of his premises.

In my opinion Isaac Newton is the greatest physicist of all time, and perhaps the greatest genius of all time, although some of his contemporaries such as Gottfried Leibniz, and Galileo Galilei were pretty important as well. There are many scientists, mathematicians, and philosophers who could be considered. (It used to be that a genius would contribute in a number of subject areas, so in some cases he could be the equivalent of a modern scientist, mathematician, philosopher, and even artist in the case of Da Vinci, all at the same time.) But everybody, even the best thinkers, are wrong about some things.

As I have been working on this project I have thought a lot about Alfred Wegener, who proposed the theory of Continental Drift in 1912. Even though Wegener had a strong argument that the continents had once been joined together, including substantial geological and biological evidence, he was laughed out of the room by other scientists of his day, which is strange because it seems so obvious that he was correct now. Even a first grader could see that the continents fit together like puzzle pieces. How could some of the best minds of that time have missed what seems so obvious with hindsight? Well, to be fair to them, it would seem strange at first to think that the continents are moving. It certainly does not seem like they are, and they are so big that it is hard to imagine what would be causing them to move, or at least it would have been back then. Even now we think that they only move by a few centimeters per year, which would have been undetectable in 1912, and maybe even now if we did not know to look for it. Wegener's theory probably seemed incredibly implausible. No wonder they thought it was not just wrong but worthy of ridicule.

The other problem was that the theory of Continental Drift was only partially correct, or at least only partially similar to what we believe today. Wegener was wrong about the mechanism for explaining the drift. The current theory of Plate Tectonics is similar to Wegener's view but not exactly the same. It is unfortunate, though, that strong empirical evidence that the continents do move, as Wegener had suggested, was only found four decades after his death, especially considering all the abuse that he had gotten because of the theory.

Realistically, I have to assume that my own view, as expressed in the sections above, will probably turn out to be somewhat like Wegener's in comparison to the current view of Plate Tectonics. I am not even a physicist, after all, I'm sure that I have gotten some things wrong. I don't know what the errors are right now, of course, or I would fix them, but if history is any guide, surely there will be some. Even Copernicus was only partially right because he still believed that the orbits of the planets were perfect circles; and even Galileo was wrong, or somewhat wrong, when he thought that the tides were caused by the sun. (It does have some effect but Newton showed that the primary cause is the the moon.) And even the great Newton was wrong about light being a stream of particles, or I believe he was. So, if I am right, then I am probably only partially right. The physicists can probably do better and make some improvements to it if they can just get headed in the right direction.

All of this does raise an interesting personal question: Which life would you rather have had, Wegener's or Einstein's? In order to answer it seems as though we need to decide whether genuine accomplishment is most important, or whether it is fame, fortune, and credit which matters most. What would be most desirable, of course, which almost everybody would want, is to have fame and fortune and to make a genuine contribution, but I think if I had to choose I would rather be Wegener.

Einstein had one of the best lives that anyone has ever had, and he believed (along with everybody else at that time) that Relativity was correct. But it was all just an illusion. I prefer truth to illusion, even if the illusion is nice and the truth is difficult to accept.

It is unfortunate that Wegener never really got to enjoy the fruits of his labors, but having celebrity and acclaim for an accomplishment cannot be considered more valuable than having it be a genuine accomplishment. It is the tragedy of doing groundbreaking work that often the creator is not appreciated during his or her lifetime. Being a trailblazer can be lonely. Sometimes it takes a few hundred years for it to catch on. That is just something that the proverbial penniless tortured artist has to accept. It is a stereotype for a reason. But it is the work that is most important. The creator can take solace in his work.

LESSONS

What can science learn from this experience even if Relativity is wrong? How can we keep this from happening again? Well, maybe we can't; we are only human after all. But I think it would help if we are more aware of, and try our best to avoid confirmation bias and inattentional blindness.

Intellectuals in both the sciences and the humanities could be more open to considering opposing viewpoints. One would think that a university would be the most tolerant environment that there is for a radically different idea, or going against the consensus, but in most cases it is actually the opposite. In science daring to go against the consensus could literally cost you your career. In both the humanities and in science it is like that with social and political issues.

The pressure to conform is very intense within this community because scientists believe that there is empirical data that proves it beyond all reasonable doubt. Anybody who still does not agree is considered a crackpot. But what everyone needs to remember is that often the argument is over how the data should be interpreted as much or more than the data itself.

For an example of how this happens (many could be given) we can look at how the de Broglie-Bohm Interpretation of quantum mechanics was received by the physics community. According to the Wikipedia article on the subject, Louis de Broglie presented the first iteration of it at the 1927 Solvay Conference. Apparently he was a fairly mild-mannered person and perhaps struggled because of that with the combativeness of the environment in trying to respond to objections in a convincing way, although some said that there was not anything wrong with his actual answers. He eventually abandoned the theory because he was discouraged by all the criticism of it.

According to the same article, David Bohm rediscovered de Broglie's theory in 1952 and developed his own take on it. But he did not have any better experience when he presented his work. The article says that according to physicist Max Dresden, when Bohm's theory was presented at the Institute for Advanced Study in Princeton, many of the objections were ad hominem attacks, focusing on Bohm's sympathy with communists as exemplified by his refusal to give testimony to the House Un-American Activities Committee - as though that has anything to do with his scientific theory.

Earlier in his career Bohm had actually published a popular textbook on quantum mechanics that adhered entirely to the Copenhagen Interpretation. Perhaps that was before he was asked to testify in Congress or it was fully known that he had some communist sympathies (or at least that is what was believed), but notice that nobody was attacking him personally for his political views back when he was saying what they agreed with scientifically.

The article includes a quote from mathematical physicist Sheldon Goldstein from 2016 in which he said this of Bohm's theory:

> There was a time when you couldn't even talk about it because it was heretical. It probably still is the kiss of death for a physics career to be actually working on Bohm, but maybe that's changing.

I don't necessarily blame Goldstein himself, he is just the messenger, but this quote really says a lot about the environment of science. Scientists tend to think of themselves as being immune from such things, but they are just like any other group with the same group dynamics. Basically it is a popularity contest. How charismatic the person is, his or her physical characteristics, for example there is such a push to get more women in science that in some instances it may help in how the work is received to be female and/or a minority, their political views etc., all matter as much or more than the scientific work itself.

I have no idea why Bohm's theory is (or has ever been) considered so heretical. I am not really satisfied with any of the current interpretations of quantum mechanics, so I am not necessarily defending the de Broglie-Bohm Interpretation over the others, but in some ways it seems more reasonable than the Copenhagen Interpretation. I really don't know why the Copenhagen Interpretation ever became orthodoxy, especially to such an extent that you could not even talk about other views without risking your career and even your personal reputation. It is really pretty ridiculous if you think about it, especially since the Copenhagen Interpretation is actually quite awful. It has to be about the personalities as much or more than the science. Apparently everybody really respected Niels Bohr, and he probably had a lot of adherents who had been trained in the Copenhagen Interpretation. That is really what it comes down to.

Theories should not be adopted or discarded based upon the group dynamics of the scientists involved. Not only is it unfair, I think it retards or perhaps in some cases even stops real progress.

Scientists (and intellectuals in other disciplines as well) also need to work on creating an environment that is more conducive to original creative work rather than just the study and explication of theories that are already well-accepted. That would mean being open enough to opposing viewpoints to really consider both sides of the argument, not being so harsh in their criticism (intellectuals can be incredibly condescending at times) and not being so cliquish.

My only experience with graduate school was a Master's program, but honestly I felt very stifled by that environment. I couldn't really use humor because it was thought to be unprofessional, and I didn't feel like I could be creative in my approach at all. It was like I had to use a template for Analytic Philosophy papers and even in discussions and one was not allowed to do anything else. I became pretty discouraged. I have actually done much better since I have been working almost completely on my own. My experience may be different than others, but I know that there are some who struggle in graduate school, and it is not necessarily because they are not as competent. The people who succeed in academic departments and at conferences tend to be the ones that are the most outgoing and talkative. The fact that they are always making comments is how others get to know them. But there could be people who are also capable of doing good work, they just do not do as well in large groups because of social reasons. They may also not be as successful if they struggle to create strong relationships with professors who can mentor them. This can have a negative impact on research because the people who have the best social skills are not always the people who have the best ideas.

The environment sort of reminds me of a religion. Many scientists would balk at that comparison, and I guess it does not have any supernatural deities, but there is an almost mystical and/or worshipful aspect to some of these theories (and sometimes with their proponents, such as Einstein). Many of the theory's adherents would defend it like a believer would defend his or her religion, and they would not abandon it any more readily when confronted with opposing evidence. Young scientists, whatever the discipline, are raised in a particular theory in undergraduate and graduate school and they are indoctrinated in it similar to how a religious person is indoctrinated while growing up in a religious home. They are older and more independent when this happens so the indoctrination is not as thorough, but it still occurs.

Because of that, in some ways being an outsider is an asset rather than a liability. An outsider is not so specialized and not so tied to the current paradigm. Not being steeped in the paradigm allows for more objectivity and also more of a bird's eye view of a theory. Also, somebody like me does not have very much to lose - if I am wrong, people think that I am just another crackpot online and hardly anybody pays attention to it, but if a physicist is wrong on something of this magnitude he or she could lose the respect of peers and what would have been a promising career. Because of those concerns a lot of people are not willing to take risks, which I think holds back progress.

I doubt that I am the first person to have thought of some of the ideas expressed above. But if some undergraduate or graduate student had some similar thoughts to mine and asked a question about it in class it would most likely just be dismissed, perhaps even condescendingly, by his or her professor. That kind of reaction would likely discourage any further investigation.

There needs to be more openness to competing theories in science, and a little more humility in assessing opposing viewpoints.