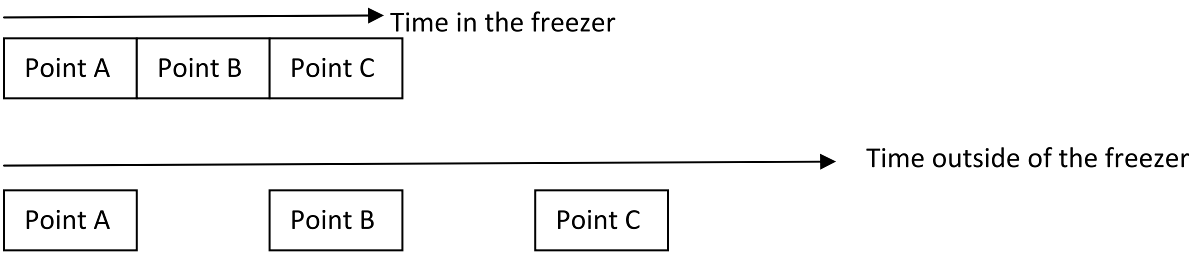
# Is time travel possible?

Throughout the twentieth century time travel has gained increasing interest, particularly since the publication of Contact in 1986. The author asked prominent scientist Kip Thorne to investigate theoretical possibilities for travel through space and time. And Thorne found that it was possible! There is nothing in Einstein's laws of relativity to say it isn't possible either. In fact quite the opposite; it seems to suggest that time travel is possible.

But in order to analyse it we must first ask what is time? Many people struggle to define it. Physicists commonly think of it as the rate of change. But I will argue that this is not a good way to think of time and that in fact 'rate of change' and 'time' are quite separate.

Einstein, and H.G Wells before him, described time as a fourth dimension after height, width and breadth (proponents of string theory and M-theory think of time as an tenth or eleventh dimension after the 9 or 10 dimensions of space). This idea states that time is a temporal dimension measuring change. But it is wrong to think of time as simply another dimension, as Einstein did, for it is the only non-spatial dimension that we know of. That alone makes it different.

So can we travel in time? If we take this meaning of time then yes of course. I could not be writing this if I could not change. We all move forward in time, for example from the time we wake to the time we go to bed. Using this definition there are time machines in every person's house. Your freezer slows the rate of change of food so that it does not go off as quickly as if you left it on the side. Yet at any point in our zone of time we can come and open the door, and the food will still be there. Why? Because only the rate of change in the freezer has slowed. Freezer food does not exist in a separate time. If it truly was moving slower in time then when I opened the freezer the next day my food would not be there, because I would have left it in the past. See the diagram below for illustration.




According to this understanding of time if I wanted to get food out of the freezer at point C I would not be able to. As the rate of change moves faster outside of the freezer, point c in the kitchen exists long after point C has occurred in the freezer. Hence if you imagine the points in the freezer to be a meal, and the points outside to be you, you would move into the future too fast for your meal to follow.

As further evidence, taking time solely as a measurement of change means that we all move at a slightly different rate through time. This is famously known as the 'Twins Paradox'. This paradox says that if one twin lives on sea level, he will experience the impact of more gravity, hence change more slowly, and hence move more slowly in time than his/her twin who lives on top of a mountain and changes faster due to the impact of less gravity. This experiment has been tested and proven. Clocks do tick faster in space where there is less gravity. They therefore seem to have moved forward through time. We can take it even further. Think about a school race. The winner's muscles move faster than the loser's muscles. Does this mean the winner is moving faster through time? Perhaps it is different here because the cells inside their bodies are still moving at roughly the same speed? Well what if they're not? If one person has an illness that causes cells to act slower does that mean they slow down in time? It is perhaps simpler to think of a solid, liquid and gas. The atoms in a gas move much faster than those in a solid. Hence are they moving faster in time?

As you can see the problem in judging time as the rate of change is in what the change is relative to. Since Einstein's theories of relativity (that built on Gallileo's earlier principle of relativity) there has been consensus that everything is relative. Yet I argue that the concepts of absolute time and space associated with Newton, are still relevant and helpful.

From the relativist point of view if the whole of galaxy A changes faster than the whole of galaxy B then time runs faster in galaxy A. This is true in a way, for while galaxy B is in year 100 galaxy A may have experienced 1000 years. Yet imagine (even if it is not possible for us to do so with our present level of technology) that we were in the position we usually think of God as being in i.e. we are sat outside of galaxies A and B and can observe both. What would we experience? Would we see one galaxy existing for 900 years and then the other popping into existence? No. We would see change happening very rapidly in one galaxy, and very slowly in the other, but both existing for exactly the same *time*. This is why I propose the idea that 'time' and 'change' are in fact very different.

We have established that it is possible to slow down the rate of change (the freezer, increasing gravity, or moving near the speed of light have these effects) or speed up the rate of change (decreasing gravity for example). But does this mean we can move in time? In a way it does mean we can move forward in time for we can slow down the rate of change in our own bodies to such a degree that we will exist for many years. A cryogenically frozen person could for example stay frozen for 100 years to be thawed looking no older. That person could then continue to live out their days with their great grandchildren, just as they could have if they stayed in their own time. But could the person simply zap themselves into the future and then come back just as quickly? No. For although that 100 years would not have made a big change on the time traveller, it would still have gone by. The traveller would still have existed through those hundred years. He/she would simply not have experienced them.

There are several theories however to suggest that we could travel in time like they do in science fiction. The most common theory of how to do this is the wormhole theory.

<u>Wormhole Theory</u>

The Special Theory of Relativity, established in 1905 by Albert Einstein, states that as a body of mass moves toward the speed of light, that mass increases in weight to the point where the energy required to move the object becomes infinite. This created the famous equation $E=MC^2$ i.e. Energy = Mass multiplied by the speed of light squared. But more importantly it implied that nothing can move faster than the speed of light. Kip Thorne, who I mentioned at the start of the article, argued that faster than light travel could be achieved with a worm hole. But he later realised that this could perhaps not only allow travel in space but also in time.

Worm holes are short cuts in space and time. They imply that space-time is curved like the Earth, and that when we travel anywhere it is like going around the Earth, hence taking an indirect route. A wormhole is literally a tunnel from point in space time to another. So to take the Earth comparison further it would be like travelling from Europe to Australia the short way i.e. through the centre of the Earth rather than around it. They are formed when two mouths, usually termed a black hole and white hole join up. Though a singularity (point in space-time where everything is condensed to such a degree that the laws of physics break down) forms in the centre for a short while a tunnel appears through the middle.

Even proponents of this theory tend to fob it off as no more than a fantasy for the tunnel is so unstable that it collapses faster than it is possible for light to travel through. And trying to send something like a spaceship through would in fact make the wormhole even more unstable. According to the general theory of relativity an accelerating object creates gravitational waves. These waves could plausibly be amplified within the tunnel, further warping space-time and closing the tunnel behind the spaceship.[1] Therefore in order to get through we would either have to travel through faster than the speed of light (not possible according to the theory of special relativity) or somehow keep the tunnel open. Talk of travelling faster than the speed of light is generally taboo in science circles. But it is still discussed. Einstein talked about 'spooky action at a distance' where different particles were able to communicate information with each other instantaneously. This action is real, and was also analysed in 'Cramer's handshaking process'. In fact Huw Price states that the past is influenced by the present and that "causal asymmetry is perspectival, a projection of our own temporal asymmetry as agents."[2] However I do not have the knowledge to discuss this any further. I would in fact be interested to know how physicists actually define information. For instance is the light coming into your eyes information? Or is the analysis of that light information? I believe more research into information theories will be crucial in unlocking future questions. For it seems likely that information is more than just the analysis of life. A future article perhaps?

A couple of theories have been advanced to explain how we could keep the tunnel open, though both require levels of energy that we can scarcely dream of at present. The reasons why the wormhole is so unstable are that firstly, it links two places/times that may be shifting, and secondly that it is subject to astronomical forces of gravity. Combating this gravity would require:

1. Motion. This would work in the same way as the solar system, where the planets rotate so fast that they balance out the Sun's gravity. So the tunnel could be rotated at high speeds. This possibility was discovered by Roy Kerr in the 60s. He found that if the black hole is rotating a singularity still forms, but in the form of a ring, therefore allowing the possibility of travel through the centre.

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[1] Some people suggest that in fact gravitational waves could act in the opposite way. This idea would see not the amplification of gravitational waves, but them cancelling themselves out as a process of negative feedback (the opposite of what takes place in a music sound system).

[2] Price, Huw; 1996; *Discussions Backward Causation and the Direction of causal processes: Reply to Dowe*; Oxford university Press; Mind, Vol.105.419.July 1996; P1; Accessible on the internet at: http://www.jstor.org/pss/2254831

2. Adding an electric charge. This would work like two magnets repelling one another, providing a second field of force. This electric charge would have the same sign as gravity and would therefore in theory repel the gravity, giving enough time for something to pass through the tunnel. However in reality you might simply be squashed between the forces.
3. Anti-gravity. The invention or discovery of a new exotic matter that would cancel out the gravitational pull. One method of anti-gravity is the 'Casimir effect'. This sees the creation of a quantum vacuum between two plates. Within this vacuum particle-antiparticle pairs would constantly create and then annihilate each other. This process would create an electro-magnetic force that could in theory counter gravity. However these anti-gravity forces are disputed by the 'weak energy condition', which rules out keeping black holes open with negative energy.

But so far we have only created a short cut in space. How do we turn this into a short cut through time? The first theory uses the special theory of relativity. If we were able to keep the wormhole open and rotate one end to near the speed of light then this end would change slower than the other due to time dilation. Hence the wormhole would literally act as a bridge between different times. This means that a person would only be able to go back to the point when the wormhole was created. Hence we have no time tourists yet because no time machine has yet been invented. I dispute that this is possible. Firstly, if one bridge was moving at different speeds in time then it is likely that we would witness the same occurrence as if it were moving at two different speeds through space i.e. it would rip itself apart. Matt Viser argued something similar in 1993 when he said that the two mouths of a wormhole could not be kept together with such a variance in time between the two without inducing quantum field and gravitational effects that would either make the wormhole collapse or the two mouths repel each other. Secondly, going back to my example about the freezer, why do two different rates of change necessarily translate into two different times? The diagrams at the bottom of the article illustrate how this would not be the case, but first I will discuss the problems commonly associated with time travel.

<u>Problems</u>

One reason people have argued that time travel cannot take place is the second law of thermodynamics. This states that entropy (disorder) always increases with time i.e. the pieces of a broken glass cannot jump back together again. It is supported by assertions that there is more disorder than order in the universe. Stephen Hawking describes this state of increasing entropy as one of three arrows of time, the other two being the psychological arrow of time i.e. the direction in which we feel time goes, and the cosmological arrow of time i.e. the direction of time in which the universe is expanding.[3] This view sees change occurring in one direction, and not logical in the reverse.

Yet firstly: who are we to define order? Order to you may mean something completely different to what your neighbour thinks. So think what an alien half way across the universe might think. Perhaps for them there is no pattern. Perhaps for them there is more order than disorder. And secondly, things do not always become more disordered. What about life? What about evolution? What about gravity pulling things together? What about our ability to glue that glass back together? Hawking

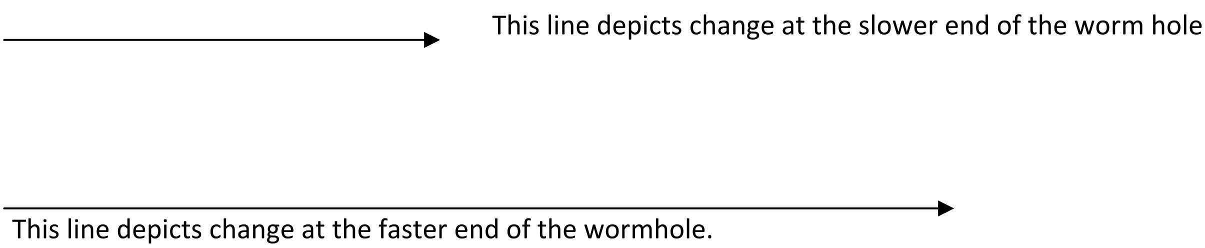
[3] Hawking, Stephen; 2005; *The Theory of Everything The Origin and Fate of the Universe*; Phoenix Books; P106-107

explains this by saying that the total sum of energy utilised to create order means that there is more disorder created with every equation. Yet that energy can continually be re-utilised. Yes a computer will waste more energy than it increases in memory after a computer operation. But the energy is not really wasted. The heat can be utilised by our bodies again. The information can also be utilised by our bodies. It all depends on what a person views as order and disorder.

The most common reason that people use to argue against time travel is the 'time paradox'. Some people refer to these paradoxes and issues of causality as 'Occam's Razor'.[4] As Stephen Hawking once said, if time travel is possible then why haven't we seen a flood of time tourists from the future?[5] The most common paradox, that I'm sure you've all seen in films, is known in physics as the 'Granny paradox'. It asks the question: what would happen if you went back in time to when your Gran was young and either killed her or caused her to stop marrying your Granddad? There are solutions to this. The most plausible is that there are an infinite number of parallel universes in which every possible eventuality takes place. This theory postulates that you could go back in time and kill your Granny. But when you went forward in time again you would either end up in a parallel universe where you were never born, or end up back in your own universe where Granny still lives (because you killed another her in another universe). It is backed up by the behaviour of electrons (subatomic particles carrying negative electric charge). When an electron is fired at a wall with two holes there is no way of telling which hole it will take. You can do the experiment twice in exactly the same way, firing the electron at the wall in exactly the same direction at exactly the same speed and the outcome will still be random. It may take hole A both times. It may take hole A the first time and hole B the second. The infinite universe theory states that every time such a choice is come across a new universe is born to allow the differences in choice. In fact it's kind of comforting in a way. Somewhere, in one universe you may actually be a lot richer and more powerful than you are here, and likewise that person you never liked could be in the gutter in the same world (though of course it swings both ways).

These problems do not seem to be too substantial as there are explanations for how we would get around most problems. But if we define 'time' and 'change' differently as I proposed, then time travel is ruled out. I will illustrate this below:

<u>Diagram 1: Direction of change</u>




> It is clear that change moves faster at one point i.e. more has happened on the second line. But what about time? Has more time passed?

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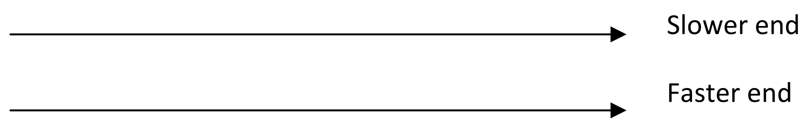
[4] www.crystalinks.com/timetravel.html
[5] One possible reason for this is the worm-hole theory of time travel as referred to earlier.

Diagram 2: Direction of Absolute Time



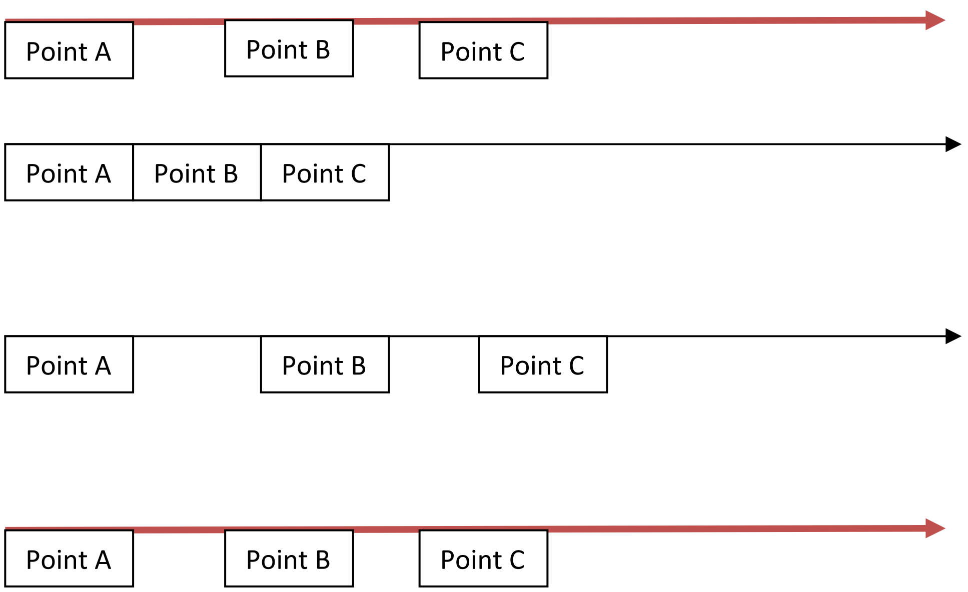

If we were able to revisit that place where we could see both points A and points B we would see both existing for the same amount of time. If the slower end were destroyed for example in year 1, then the faster end would also be destroyed at the same time. It is simply that more change would have occurred at the faster end. So if we were able to put babies into each end and keep them there, the baby at the faster end would die an old man/woman. However the baby at the slower end would die a toddler.

Time relative to those people has passed differently. But relative time is the rate of change. Both still exist for the same time if we are able to discuss the concept of absolute time i.e. change relative to all things, like it would be in the eyes of a God (just because we cannot see all things does not mean they do not exist, and the theory cannot be discounted on this basis) .

Diagram 3: Relative Time and Absolute Time

Taking the concept of absolute time into account, could we move from one point in relative time to another? I.e. could we move from state of change 10 in one place to state of change 1 in another? Unfortunately the answer is still no by this means.

As we travel from the fast end of the wormhole to the slow end our rate of change would slow but we would never go into negative movement through time. We would leave the slower part of the wormhole in fact after we had entered through the faster end.



The two black lines represent time in the two ends of the wormhole. The two red lines represent time in our reality outside of the wormhole at either end of the tunnel. Assuming we are travelling only in time and no more than a few metres in space then the witness standing outside the wormhole would always be able to see or feel both sides of the tunnel. Hence although you could travel between points B and C on the two black lines, you would in reality only be travelling between point B and point B.01 on the red line, i.e. if it took you a minute to get through the wormhole then you would emerge a minute into the future (bearing in mind the traveller would change at the same rate as the black/white hole he/she is travelling through and therefore may still experience time differently to the observer). Time for the witness would still be relative to the rest of the galaxy, and that galaxy would not change at a different rate; only the black-hole and white-hole would.