TIME TRAVEL – A POSSIBILITY?

"Time will tell how much I love you" – Christine

Time travel – as complicated as it sounds, is simply defined as 'moving between different points in time'. This concept has been popularly used to blow our minds in Sci-fi movies and series ranging from 'Star Trek' to 'Back to the Future' to 'Interstellar' to 'Avengers – Endgame', where we see humans using some sort of device, may be a vehicle or even a wearable of some sort to arrive in the past or future, ready to take on new adventures. But, each of them have their own theories about time travel. So, which one is right? In reality, the concept of time travel is more muddled. Not all scientists believe that time travel is possible. Some say that even attempting such a feat would be fatal to any human who chooses to undertake it. So, before we can go any further in actually attempting such a 'thing', we need to understand the core concept of time travel, which is time itself!

So, What is time? If I asked you to describe the concept of time to an 8-year-old, how would you actually do it? Well, you would ask them to look at a clock. That's the basic way of actually telling them what 'the time is'. But, as familiar as the term 'time' sounds, it's hard to define and understand it. Time, as we say, is a passing non-stop. You can follow it with calendars and clocks, yet, we cannot study it with a microscope or even experiment with it. We still cannot say what exactly happens when time passes. Time is but our 'Past, Present, and Future'. While most people think of time as constant, Albert Einstein showed that time is an illusion. Now that just sounds bonkers! How can u say time is an illusion, when you can actually 'see it pass' in front of your own eyes! Time is represented through change, it may be as simple as the circular motion of the moon around the Earth, the Earth around the Sun, or even the Earth around its own axis. So, now we are saying that the passing of time is closely connected to the concept of space! Well, what Einstein means to say, is that time is relative – it can vary for different observers depending on your speed through space. To Einstein, time was the 'Fourth dimension.'

We know that space is described as a three-dimensional arena, with coordinates such as length, width and height, to determine the location of a certain object. 'Time' here provides another coordinate – direction – although conventionally, it only moves forward. This is called, 'The Arrow of Time', which says that time in the natural world has one direction. Now you may argue about time moving backwards. There is a simple explanation to resolve that dispute. The natural world follows the laws of thermodynamics. The second law of thermodynamics states that within a closed system, the entropy of the system remains constant or increases. If the universe is considered to be a closed system, its entropy (degree of disorder) can never decrease. In other words, the universe cannot return to exactly the same state in which it was at an earlier point. Time cannot move backward. So, now that query is resolved, let's move forward.

Einstein's theory of special relativity says that time slows down or speeds up depending on how fast you move relative to something else. Approaching the speed of light, a person inside a spaceship would age much slower than his twin at home. Also, under Einstein's theory of general relativity, gravity can bend time. Now that sounds absurd right. Let me explain it with a small experiment.

Picture a four-dimensional fabric called space-time. When anything that has mass sits on that piece of fabric, it causes a dimple or a bending of space-time. The bending of space-time causes objects to

move on a curved path and that curvature of space is what we know as gravity. This can result in time dilation, where the time between events becomes longer (dilated) the closer one travels to the speed of light. Moving clocks run more slowly than stationary clocks, with the effect becoming more pronounced as the moving clock approaches the speed of light.

Now that finishes the refresher course on ‘Time’ and ‘Space’. Let’s now come back to what we started with, our topic of concern, ‘Time travel’. Jumping forward in time occurs in nature. Astronauts on the International Space Station jump forward in time when they return to Earth because of its slower movement relative to the station. The idea of travelling back in time, however, poses problems. One issue is causality or cause and effect. Moving back in time could cause a temporal paradox. The "grandfather paradox" is a classic example. According to the paradox, if you travel back in time and kill your grandfather before your mother or father was born, you could prevent your own birth. Many physicists believe time travel to the past is impossible, but there are solutions to a temporal paradox, such as traveling between parallel universes or branch points.

General relativity also provides scenarios that could allow travellers to go back in time. The equations, however, might be difficult to physically achieve. One possibility could be to go faster than light, which travels at 299,792,458 m/s in a vacuum. Einstein’s equations, though, show that an object at the speed of light would have both infinite mass and a length of zero. This appears to be physically impossible, though some scientists have extended his equations and said it might be done.

One way would be to create ‘wormholes’ between points in space-time. A wormhole or Einstein–Rosen bridge, is a speculative structure linking disparate points in spacetime and is based on a special solution of the Einstein field equations. A wormhole can be visualized as a tunnel with two ends at separate points in spacetime (i.e., different locations, or different points in time, or both). A wormhole could connect extremely long distances such as a billion light years or more, short distances such as a few meters, different universes, or different points in time. While Einstein’s equations provide for them, there is a high chance of it collapsing very quickly and would only be suitable for very small particles. Also, scientists haven’t actually observed these wormholes, and the technology needed to create a wormhole is far beyond anything we have today.

While Einstein's theories appear to make time travel difficult, there are alternate solutions to jump back and forth in time. In 1974, Astronomer Frank Tipler proposed a mechanism. known as a Tipler Cylinder, where one would take matter that is 10 times the sun's mass, then roll it into a very long but very dense cylinder. After spinning this up a few billion revolutions per minute, a spaceship nearby following a very precise spiral around this cylinder could get itself on a "closed, time-like curve". There are limitations with this method, however, including the fact that the cylinder needs to be infinitely long for this to work.

Another possibility would be to move a ship rapidly around a black hole, or to artificially create that condition with a huge, rotating structure. Physicist Stephen Hawking wrote, ‘Around and around they'd go, experiencing just half the time of everyone far away from the black hole. The ship and its crew would be traveling through time. Imagine they circled the black hole for five of their years. Ten years would pass elsewhere. When they got home, everyone on Earth would have aged five years more than they had.’ However, he added, the crew would need to travel around the speed of light for this to work.

Another theory for potential time travelers involves something called cosmic strings, narrow tubes of energy stretched across the entire length of the ever-expanding universe. These thin regions, left over from the early cosmos, are predicted to contain huge amounts of mass and therefore could warp the space-time around them. Cosmic strings are either infinite or they are in loops, with no ends, scientists say. The approach of two such strings parallel to each other would bend space-time so vigorously and in such a particular configuration that might make time travel possible, in theory.

All these are just alternate time travel theories which haven't been proved yet. It is generally understood that traveling forward or back in time would require a device, a 'time machine', to take you there. Time machine research often involves bending space-time so far that time lines turn back on themselves to form a loop, technically known as a 'closed time-like curve.' To accomplish this, time machines often are thought to need an exotic form of matter with so-called 'negative energy density.' Such exotic matter has bizarre properties, including moving in the opposite direction of normal matter when pushed. Such matter could theoretically exist, but if it did, it might be present only in quantities too small for the construction of a time machine.

However, time-travel research suggests time machines are possible without exotic matter. The work begins with a doughnut-shaped hole enveloped within a sphere of normal matter. Inside this doughnut-shaped vacuum, space-time could get bent upon itself using focused gravitational fields to form a closed time-like curve. To go back in time, a traveler would race around inside the doughnut, going further back into the past with each lap. This theory has a number of obstacles, however. The gravitational fields required to make such a closed time-like curve would have to be very strong, and manipulating them would have to be very precise.

So, is time travel possible? Will we ever get an opportunity to travel through time? While time travel does not appear possible, at least for now, possible in the sense that humans would survive it, with the physics that we use today, the field is constantly changing. Advances in quantum theories could perhaps provide some understanding of how to overcome time travel paradoxes. One possibility, although it would not necessarily lead to time travel, is solving the mystery of how certain particles can communicate instantaneously with each other faster than the speed of light. In the meantime, however, we can at least experience it vicariously through movies, television and books. As the late Stephen Hawking said in his book 'Black Holes and Baby Universes', 'The best evidence we have that time travel into the past is not possible, and never will be, is that we have not been invaded by hordes of tourists from the future.'

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