The Concept of Time

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1.Introduction

Did you oversleep today? Were you in a hurry to get to school ON TIME? We have all went through this. We have all been under pressure because of time. It is all around us. But is it what we think it is?

Time seems to flow forward… But can it run backward? Do events unfold one after another, or do past, present and future exist side by side? Is time a fundamental part of the Universe, or could it be that time does not really exist?

What time is it? I could tell you it is 7:14 p.m., but your time may vary, depending on where and when you are. But for most of us time is a set of numbers we use to gauge our days. We live our lives by the clock – waking up, racing to work, going to bed, and on and on. However, it was not always like that.

2.Does time exist?The flow of time.

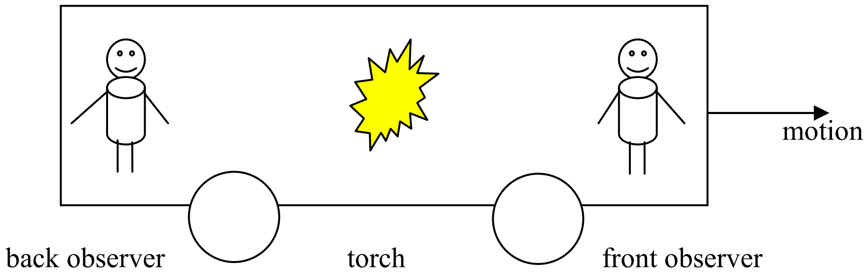
The concept of time is related with the motion and the change in the objects around us.All objects begin, develop and end in time and that holds true not only for us , the human beings, but also for the stars and the universe.In the Newtonian physics time is used as a parameter to describe the motion of objects.But this does not necessarily mean that time exists in reality.

We can't perceive time itself but only the **flow of time**.Every instant the present turns into past and the future - into present.We feel this passage of time because the past is quite different compared with the future: we have memories of the past, but we don't know anything about the future.And we cannot stop the present: even when we are talking about the present instant, it's already gone into past.Since the flow of time makes a given moment come on the present stage only for an instant and the past and future exist only in our consciousness, one may think that time doesn't exist in reality but is only a psychological phenomenon.

We shall prove, using the theory of relativity , that time actually doesn't flow and this is an indication for the real existence of time.Let's regard a model of the space-time suggested by Brian Greene(ref.1).He considers the universe as a sliced loaf of bread(Fig.1).Each slice is a time cross section of the universe, i.e. it contains all the events that take place in the entire universe at a certain instant according to a given observer.If he could look at this picture from above , he could see all the events from the past, the present and the future in the different slices, like the Big Bang, the origin of the Sun, the birth of his future

children or the collision of the Milky way with the Andromeda galaxy.But he is in the space-time and cannot go out of it to see all these time cross sections altogether.He sees only one by a time as though there is a mechanism like the light of a torch that illuminates the slices of time one after another only for an instant , after which they disappear in the darkness.But such a physical mechanism that can separate one moment from another is not yet found.

What then justifies this model?It is the theory of relativity.It reveals that if two observers move with respect to each other, they don't agree on the simultaneousness of events and consequently their present time cross sections are not the same.Imagine two people standing at the front and at the back of a long wagon that moves.



A torch which is exactly at the center of the wagon, flashes light.According to the two people on the wagon, the light reaches them at the same moment because it travels equal distances at the same speed.That's why the arrival of the light to the two observers lies in the same time cross section.But for someone waiting at the station, the person at the back moves towards the emitted light, while the person in the front moves away from it.The light travels at the same speed for all the observers.That's why the back observer will receive the light at an earlier moment than the front observer,i.e.these two events lie in different time cross sections for this observer.Thus the present time sections (pts) according to the various observers consist of different events and we can think of them as being rotated from each other at a certain angle(Fig.3)

What is more important for the sake of our investigation is that the pts of different observers differ not only when they move with respect to each other but also when they are at rest but at a very great separation distance.This is because light needs time to cover distance and the universe is a time machine: the farther you watch, the more back in time you see.Hence the present events for the one observer may not be yet present for the other since light needs different time to travel to their separated positions(Fig.4)

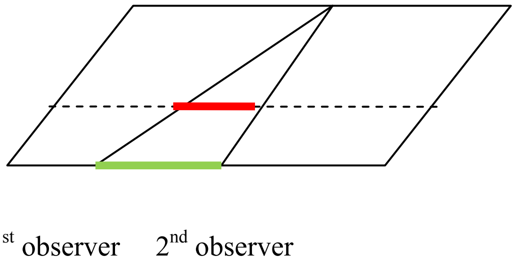


Fig.3 Fig.4

The bigger the separation distance between the observers, the more their pts are displaced from each other and the perception of the observers about the present is quite different.As a result in an infinite universe the pts for all the observers, at any place in it, are rotated at all the possible angles and contain the events in the entire space-time.**This is how all the events that happened, happen or will happen for a given observer really exist since they are the present for another observer and the point of view of all the observers is equally true since there are no privileged observers.**

2.Time as the 4-th dimension.

There are 3 dimensions in space: up-down, left-right, forth-back.All objects exist in 3 spatial dimensions: length, breadth and height.Einstein revealed that time can be considered as the fourth dimension.To prove that time is identical in its nature with the spatial dimensions we shall use a model in which space -time is associated with a staircase each step of which represents one dimension(ref2).

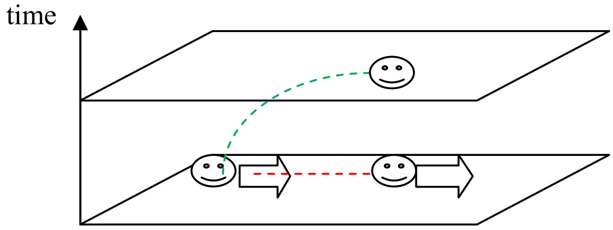
Fig7

Fig5

Fig6

Fig 5 illustrates someone who stands on the lowest step and can easily see the surface of the first 3 steps(these are the 3 spatial dimensions) but he can hardly see the surface of the 4-th step because it is partly blocked from his view(this step being the time dimension).Fig 6 represents another observer who is one step shorter than the first one.He can easily see the surface of the first and the second step but can hardly see the surface of the third step.We can think of this observer as living in a two dimensional space(a flatland) and our 3-rd space dimension has become a time dimension for him.The figure represents someone who lives in hyperspace of 4 spatial dimensions(he is one step taller than us) and for him our time dimension is a space dimension.These considerations show that the **time dimension is actually just another spatial dimension but that only becomes clear when you move up and down in the dimensions.**

If there were only space dimensions we could not perceive speed.Speed is a division of distance covered in space to distance covered in time.We cannot see our speed in time because we can not measure distance in time.But we must think of our 3D space as moving as a whole along the time dimension.To visualize this imagine someone who lives in a flatland.For him our 3rd dimension is time dimension.His 2D space moves along the t dimension: he cannot see that but it is visible for us.Simmilarly our motion in the time direction can be seen as spatial speed for someone who lives in a 4D space.

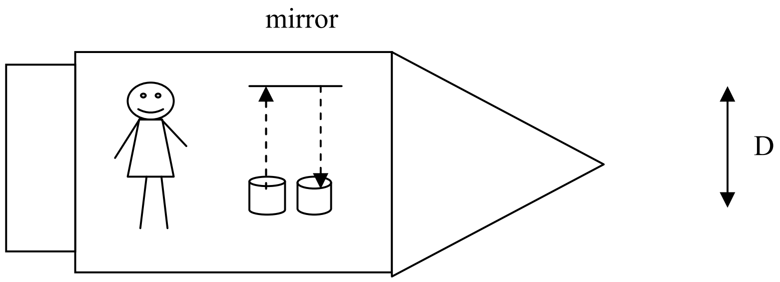


The 2D beings can see only their spatial speed but cannot see their speed-in-time.

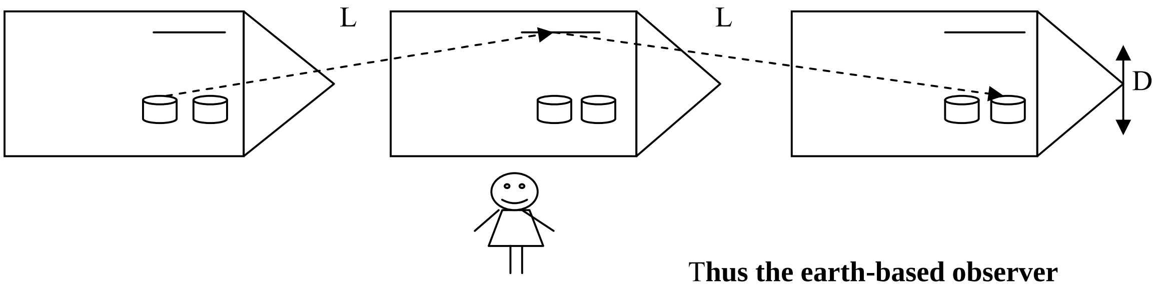
3.The relativity of time.

3.1.Time dilation

Common experience indicates that time passes as quickly for a person standing on the ground as it does for an astronaut in a spacecraft.But the theory of relativity proves that **the duration of the time interval between two events varies for different observers depending on whether the events take place at the same location or not with respect to the observer.**For example suppose an astronaut flying in a spacecraft at a constant velocity relative to the earth.Aboard the spacecraft there is a light clock and the astronaut is at rest with respect to it.The clock consists of a source of light that emits a pulse, a mirror that reflects the pulse and detector that registers the reflected pulse.The emission and the detection of the pulse occur at the same location for the astronaut.According to the astronaut, the time interval between the emission and detection of the pulse is $\Delta t_0=2D/c$

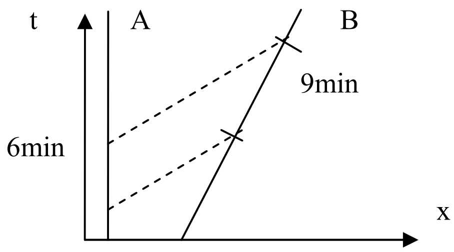


An earth-based observer with respect to whom the emission and detection of the pulses occur at different locations , does not measure the same interval between these two events.This observer sees the light pulse follow a diagonal path L instead of the up/down path seen by the astronaut and it is longer than D.But light travels at the same speed for both observers, in accord with the speed of light postulate.



Thus the earth-based observer measures a longer interval $\Delta=2L/c$ between these two events.This result is known as time dilation.

To make it clearer(Ref3) we shall draw a space-time diagram for the two observers and shall assume that every time the light is emitted or detected by astronaut's watch, he flashes an electric torch.The astronaut A is in the origin of a coordinate system whose vertical axis represents time as measured by him,



the horizontal axis represents distance.Because A considers himself to be at rest and thus is not going anywhere along the distance axis, his x-coordinate remains 0.But in the course of time A moves along the time-axis and thus follows a straight line in the diagram, parallel to the time axis.When A flashes a pulse, the earth-based observer B is at a certain distance from A along the x-axis.B moves with respect to A(or A with respect to B) and consequently not only his time but also his x-coordinate change.If B moves at a constant velocity he covers equal distances within equal intervals of time and hence follows a straight line in the diagram which is inclined with respect to the line of A(the steepness of the line depends on the magnitude of the speed).The pulse travels with the speed of light from A to B.The light has the greatest speed and therefore its line in the diagram has the biggest possible slope of 45^0.After some time(which depends on how far B is from A)the pulse reaches B.After say 6 min according to A's watch he flashes a second pulse.As B moves away from A this flash has to travel father to reach him than the previous one and is therefore longer in transit.Accordingly by B's watch the flash arrives not after 6min but at a longer interval say 9 min.

If A travels at a greater speed, B's line in the diagram will be steeper and the time interval measured by B will be bigger.Or A , who is travelling with respect to the Earth, will measure a shorter interval compared with B.The faster you travel wth respect to the earth , the slower the time passes.

3.2.Time and gravity.

Einstein revealed that gravity also affects time.In a stronger gravitational field time passes more slowly.For example someone living on Jupiter will age more slowly than people on Earth or the astronauts who spent some days on the Moon returned older.The argument for this is the **principle for the equivalence between gravity and accelerated motion**.Imagine you are floating weightless in a box .If suddenly the box begins to accelerate you will feel weight as you are pressed against one side of the box, i.e. accelerated motion has the same effect as gravity.

In an accelerated motion every successive second one gains speed.But we have already shown in 3.1. that the faster one moves the slower the time passes.

3.2.The twin paradox.

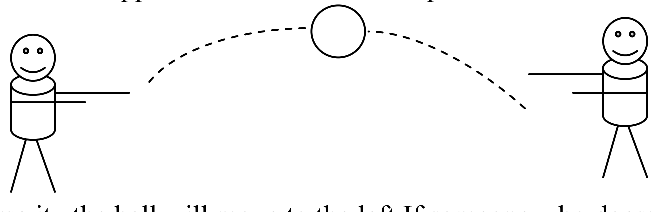
An interesting aspect of time dilation is space travel.If a rocket leaves for a distant star at a speed closer to the speed of light relative to the earth, it will take less time for the passengers to reach the star than for people on the earth and when the passengers return to the earth they will be yonger.The arguments that lie behind this conclusion are the following.The two events in this situation are the departure from earth and the the arrival at the star.With respect to the earth-based observer the two events are not at the same location.Cosequently the time interval between them is longer.On the contrary, for the passengers the events take place at the same place: at departure, earth is just outside the spaceship, upon arrival at the the star it is again just outside.Therefore, in relation to the passengers the time interval between these events is smaller.As a result, their hearts beat slower and they return to earth younger.If they travel for 1 day and then return to earth, they will be 1 day older but for the people on Earth will have passed hundreds of years.The passengers will return to find that everyone they have known is longdead.

4.The time arrow.

4.1.Why is there a time arrow?

Time doesn't flow but there is a definite direction in which things evolve.Common sense gives us an indication for the existence of the time arrow.For example if a glass falls to the ground it crushes into many small pieces but the pieces never gather to form the glass again; a hot tea has the tendency to cool but never becomes hotter by itself; a drop of perfume released in a certain part of a room spreads in the entire room but never locates back in a drop.These events happen in a definite direction and never in the opposite one , which gives us the concept of past and future.

What is the fundamental law that dictates the arrow of time?The mystery is that nobody has found such a law.What is more: the laws of mechanics, electromagnetism and relativity reveal a perfect symmetry between past and future.These laws state that, contrary to our experience, all events could happen in the opposite direction.For example a child is throwing a ball to the right towards another child .



If we make a film of its trajectory and reverse it, the ball will move to the left.If someone who doesn't know what has happened watches the film he won't be able to guess in which direction the ball really moves since the laws of physics allow the motion in both directions.Here we don't reverse time but just make the object pass along the same path in the opposite direction by reversing the speed of the object.

It is easy to reverse the speed of the ball but as far as the crushed glass is concerned, it is much more difficult to reverse the speed of all the broken pieces in order to form the glass: we must catch all the flying pieces and throw them with the same speeds in the opposite direction.**The very idea that unveils the mystery of the time arrow is in the contrast between easy and difficult**: easy things usually happen while difficult things are almost impossible to happen.

4.2.Entropy and the second law of thermodynamics.

Entropy is a measure of "disorder" (the higher the entropy, the higher the disorder). It indicates what is the degree of chaos in a system.**The second law of thermodynamics says that as time goes on, entropy increases.**Here is an example showing clearly what entropy is: imagine you went out with friends to play pool. At the very beginning of the game, all balls are in perfect order, but when the fist player takes his turn, he 'inserts' chaos on the table and in the course of the game there is no chance to establish order out of the chaos.

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Thus for any system of many elements there is a natural evolusion in the direction of a bigger disorder.The law comes from the fact that there are so many ways to make disorder and only a single way to arrange the elements of the system in a given pattern.As a result a state of greater entropy is more probable in the course of time and it is what we usually observe.The law doesn't deny that a state of smaller entropy can appear but the probability of this is very small and that's why we don't observe it.

4.3.How is the time arrow explained?

The second law of thermodynamics doesn't explain the time arrow.According to Brian Greene the second law gives an entropy that increases in future but this doesn't mean that it necessarily have decreased in past.Since the laws of physics are blind for the difference between past and future, the entropy may increase in the past too,i.e. if a system doesn't have the maximum entropy, it is very probable to progress in future or to have been in past in a state with a greater entropy.If this is the case and if the universe came into being from a state of great disorder, to develop to the present state of high order there must have been a very rare but possible fluctuation .Why then we never witness such fluctuations?

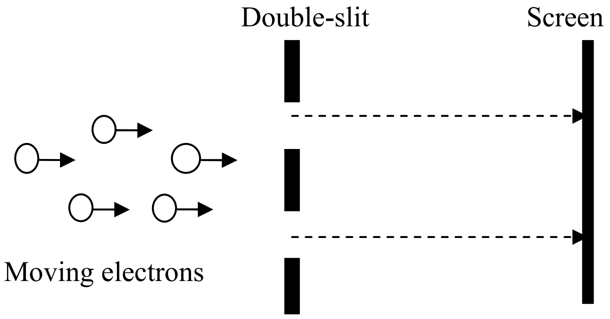
4.4.The entropy of the universe after the Big Bang.

During its life time living beings gain energy in the form of food which is as much as the energy released in the form of heat and waste substances.But these two types of energy differ in the degree of their entropy: heat has a high entropy while the energy accumulated in food (plants) has low entropy.But where does this low entropy in plants come from?Plants use solar energy for photosynthesis and therefore the Sun has even smaller entropy than plants.The Sun was born in a cloud of interstellar gas which must have a smaller entropy than the Sun.The interstellar cloud appeared soon after the Big Bang.Scientists know now that 2 minutes after it the universe was filled with an almost uniform hot gas of hydrogen and helium.But how can a system of gas have small entropy since its molecules are in great disorder?This is only true for a low density gas within which gravity can be neglected.But if the gas has a great density gravity is big enough to come into play and it is the reason for the low entropy of the gas.These arguments reveal that **the time arrow could have its explanation in the highly ordered low entropy state of the early universe.**

5.Time in quantum mechanics.

5.1.The uncertainty principle.

According to the Heisenberg uncertainty principle it is fundamentally impossible to determine simultaneously the speed and the position of a particle. $\Delta p.\Delta x \geq h/2\pi$ Where Δp is the uncertainty in the particle's momentum, Δx is the uncertainty in the particle,s position and h is Planck,s constant.The equation indicates that Δp and Δx cannot both be arbitrarily small at the same time, i.e. if we know the position of the particle at a given instant (Δx is 0) we don,t know its momentum(Δp is an infinitely large number) and hence we can't determine its position at the next instant.The particle could be in any other position including somewhere at the other end of the universe.That makes us abandon two of the most deeply rooted concepts imposed on us by common experience and Newtonian physics: there is no trajectory along which particles move and the present is not uniquely determined by the past.   One manifestation of this principle is the double-slit experiment.



A beam of electrons is directed to a double-slit.When an electron passes through the double slit arrangement and strikes a spot on the screen, the screen glows at that spot.If every electron moved on a straight line following a defined trajectory we should see two fringes on the screen just behind the two slits.But that's not the result .The experiment reveals an interference pattern of many fringes. Bright fringes occur where there is a high probability of electrons striking the screen, and dark fringes occur where there is a low probability.But how do electrons interfere? To eliminate interaction between electrons when passing through the double-slit, they can be shot one after another so that only one electron passes through the arrangement at a time.But the result is again an interference pattern.How is that an electron interfers with itself? Feynman suggested that the observable present (i.e. the interference pattern) is a superposition of all the possible paths of the electron.Every electron can be associated with a wave of probability whose magnitude at a point in space gives an indication of the probability that the particle will be found at that point.At the screen the pattern of probabilities conveyed by the particle waves causes the fringe pattern.

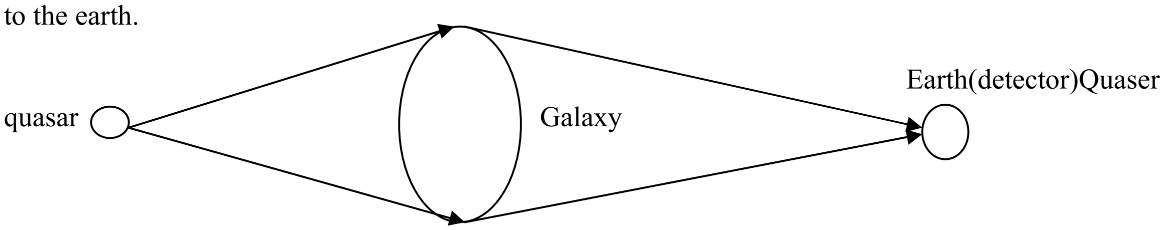
Does this mean that the electron passes through both slits or it passes only through one of them and the superposition of all the possible paths is only a mathematical trick we use to describe the interference pattern we see on the screen?If we try to identify through which slit exactly the electron passes by placing a detector near the slits to watch the electron, it will pass only through one of the slits and the interference pattern disappears on the screen.And this puts forward another question: how can our observation change the final result.There are two possible answers to these questions.

5.2.The first answer :The complementarity principle.

According to Niels Bohr objects like electrons or photons have both the properties of particles and waves.In the double-slit experiment an electron passes simultaneously through the two slits and behaves like a wave when not observed but when we watch it one of its really existing paths becomes dominant and it is the one we register.In other words our way of interaction with the electron makes its particle or wave characteristics prevail and we accept the electron as a particle or as a wave.The quantum mechanics gives us a possibility to explain the observed present by a superposition of all the possible paths but doesn,t allow us to follow the exact path that has lead to the present.

5.3.The second answer:Can future change the past?

Let ׳s suggest that the electron passes only through one of the slits even when it is not observed.Then our observation makes the electron sum all the possible situations, find the average value and choose one of the results which is the one we observe.But if this is true it means that the past doesn׳t exist in reality and we determine it or even can change it from the position of the future.The absurdity of this situation can be seen for example in the following experiment. Consider a distant quasar whose light, on its way to us, passes by a galaxy).Its gravity acts as a lense that focuses the light directing the photons to the earth.



The emitted photons by the quasar can pass on either side of the galaxy after which they travel billions of years (since the quasars are the farthest objects in the universe) and finally they gather in our detector.If we don,t watch on what path the photons travel, it will come out that they moved on both sides of the galaxy billions of years before now and we shall have an interference pattern.But if we now decide to check the exact path of the photons, they must change the choice they have made billions of years ago(when the Earth didn׳t exist yet) to pass only on one of the paths.Then we can switch the detector off and the past of the photons again will change.If the past depends on our observations it does,t really exis

Scientists do not accept such a situation. They claim that the past really exits but it exists as a mixture of a lot of possibilities, which crystallizes in one certain reality only when the proper measurement is conducted.The observation puts forward one of the all possible options..**Future cannot change the past but only the way we describe the past can differ according to our interaction with it.**

6.Going backward in time.

Can matter go backward in time? The answer to this question is formally yes. Let's see how it is possible.Feynman in 1940 noticed that antimatter travelling forward in time was indistinguishable from ordinary matter going backward in time.

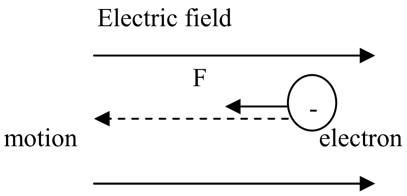


Fig8

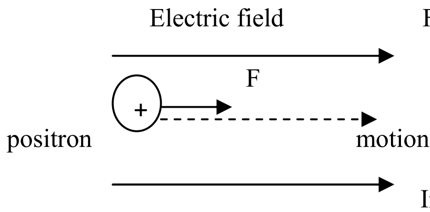


Fig9

In Fig 8 the electric force moves the electron to the left.If the electron was going backward in time it would move to the right.But Fig 9 indicates that this is possible if the negative charge of the electron has changed into a positive one (since an electric force can move a positive charge in the direction of the field lines),i.e. the electron has turned into a positron. Carl Anderson performed a cosmic ray experiment in which he first detected an electron with a positive charge(a positron).It can be regarded as an electron going back in time.

An interesting theory of the universe arrises from this understanding.The whole universe may consist only of 1 electron.Suppose that out of the energy of the Big Bang came only 1 electron.This electron moves forward in time for billions of years until it arrives to another cataclysmic event – the end of time.Then the electron releases a burst of energy and an antielectron (positron) appears which can be regarded as an electron moving back in time.At its arrival back at the Big Bang its direction is reversed once again.In this way the same electron zigzags back and forth between the Big Bang and the Doomsday.We can assume that the electron has traveled enough time to create the sum total of the electrons in the universe.Here we must have in mind that although objects travelling in space can not create copies of themselves, objects travelling in time create copies of themselves at any moment since, as we have already discussed, all moments exist simultaneously in reality.According to this theory all the electrons in our bodies are the same electron, the only difference being that they have different age.

Conclusions

Our whole 3D world travels along a 4th dimension called time.We pass through the different slices of time-space which really exist with all the events we have experienced and have not yet experienced.Some observers move faster in time depending on their speed and the strength of gravity.This is an one way journey since all the events evolve in the direction of a greater disorder, a process which has started from a very orderly state of the universe just after the Big Bang.On a microscopic level particles move from here to there along many different paths but in a final observation a choice is to be made and the observed world is the final incarnation of that choice.

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