

It's difficult to think of a more fascinating and thought-provoking view than a starry night sky. There is a thing about the twinkle of the cosmos that makes us pause and think of the deepest mysteries of the world.

A Brief History of Time will assist to explain these secrets by revealing the laws that guide the world. This history is written in easy language, and it will also assist even the non-scientifically minded to know the reason why the world is in existence, how it began and what the world will look like in the nearest future.

Also, we will learn about strange occurrences; such as black holes which sucks up all the things (well, nearly everything) toward them. Also, you'll learn about the secrets of time itself; as these book chapters offer the solutions to questions such as "how fast is the time going?" and "how do we identify if the time is going forward?"

It's okay to mention that after you have read this book, you'll never see the night sky in quite the same manner anymore.

## Chapter 1 - Theories that based on the things you've noticed before can assist foretell the future.

You've most likely heard about the theory of gravity or the theory of relativity. However, have you ever stopped for a while to ponder on what we actually mean when we discuss theories?

In lay's man term, a theory is a model that precisely clarifies huge groups of observations. Scientists gather data from the observations they notice, for instance, during experiments, and make use of those observations to form reasons of how and the reason event occur.

For instance, after Isaac Newton observed a lot of incidences such as apples falling off from trees to the movements of planets; he formed the theory of gravity. By making use of the data he gathered he was able to explain gravity in a theory.

Theories have two huge advantaged:

Firstly, they enable scientists to make certain predictions about future incidences.

For instance, Newton's theory of gravity enabled scientists to forecast future movements of things such as planets. If you desire to know, say, for instance, the position of Mars six months from now, it's likely to forecast this exactly with the theory of gravity.

Secondly, theories are usually disprovable, this entails that they can be reformed if new proof that doesn't fit the theory is discovered.

For instance, at a time, people trusted in the theory that all the things in the work revolved around the Earth. This theory was disproved by Galileo when he observed moons orbit Jupiter; hence, he could prove that truly, not all the things orbit the Earth.

Therefore, basically, one future observation can usually cancel a theory, irrespective of how reliable it looks at the present. This entails that theories can never be proven right, and this is what makes science a continuously evolving process.

## Chapter 2 - During the 1600s, Isaac Newton changed the manner we think about the movements of objects.

Before the time Isaac Newton, people assumed that an object's natural position was at absolute rest. This entails that if there is no force acting on it, then the object would stay totally immobile.

During the 1600s, Newton carefully disproved this long-held conviction. As a replacement for it, he created a theory that stated that every object in the world, rather than being still, was as a matter of fact in constant motion.

Newton discovered this from his finding that the stars and planets in the world were moving constantly in relation to one other. For instance, the Earth is orbiting the Sun constantly and the whole solar system is rotating around the galaxy. So, nothing is still forever.

Newton formed three law in order to explain how every object in the world move

The first law of Newton states that every object will keep moving in a straight line provided it is not acted on by another force. This was shown in an experiment conducted by Galileo where he rolled balls down a slope. Because gravity was just the only force acting on the balls, the ball rolled in a straight line.

The second law of Newton law states that an object will accelerate at a rate proportional to the force acting on it. For instance, a car that has a stronger engine will speed up faster than the care with a less strong engine. This law also states that the more the body's mass, the less a force affects its motion. For instance, if we have two cars with the exact engine, the heavier car will take more time to accelerate.

The third law of Newtown explains gravity. This law states that all bodies in the world attract other bodies with a force that is proportional to the mass of each object. This entails that if you double the mass of an object, the force will be two times as great. If you double an object's mass and you triple the other object, the force will be six times as great.

## Chapter 3 - Due to the fact that the speed of light is constant demonstrates that you can't constantly measure the speed of something relative to another thing.

So we understood how Newton's theory put an end to the absolute rest and changed it with the notion that the movement of an object is relative to the movement of another thins. Also, the theory proposed that the speed of an object is relative.

For instance, assuming you are sitting on a train that is traveling at 100 mph and you are reading a book. So how fast are you traveling? According, to a passerby seeing the train speed past, you are traveling at a speed100 mph. However, your speed is zero mph relative to the book you are reading. Therefore, your speed is relative to a different object.

Still, one huge hole was formed in Newton's theory: the speed of light.

The speed of light is actually constant and it is not relative. It is 186,000 miles per second all the time regardless of how fast something else is going, the speed of light stays the same.

For instance, if that train were moving fast towards a beam of light at 100 mph, the speed of light would still remain 186,000 miles per second. Still, if that train halted at a red signal, the beam of light would remain at 186,000 miles per second. Regardless of the person that is seeing the light or how fast they are traveling, its speed will be the same all the time.

This truth brought a lot of issues for Newton's theory. How is it possible for the speed of something to be constant irrespective of the state of the onlooker?

The solution was discovered during the early twentieth century when Albert Einstein stated his theory of relativity.

## Chapter 4 - According to the theory of relativity, time itself is not set.

Due to the fact that the speed of light is constant, this was an issue for Newton's theory, because it verified that speed wasn't constantly relative. So, scientists require a modernized model that took into consideration the speed of light.

Albert Einstein created that kind of theory which is the theory of relativity.

The theory of relativity proposes that the laws of science are equal for every freely moving onlooker. This entails that regardless of what a person's speed might be, they would witness the exact speed of light.

This might look somewhat direct at first look; however, one of its vital suggestions is really hard for a lot to understand; it proposes that time is relative.

What this entails is that since the speed of light remains the same for onlookers moving at various speeds, onlookers traveling relative to each other would really measure different times for the same event.

For instance, assuming a flash of light is transmitted to two observers: one observer is traveling toward the light and the other one traveling at a fast speed in the other way. For both of the observers, the speed of the light would be exactly the same, although they are traveling at pretty different speeds and going in opposite ways.

Strangely, this would entail that each of them feels the flash event as if it occurred at two separate times. The reason is that time is calculated by the distance an object has traveled divided by its speed. Both observers experience that same speed of light; however, because the distance is different, time is relative to each observer.

If each of the observers took clocks to measure when the pulse of light was released, these would verify two different times for the exact event.

Therefore, who's correct? None of the observers; time is relative and exceptional to both observers' viewpoints!

## Chapter 5 - Because one can't make precise measurements of particles, scientists make use of something known as the quantum state to forecast.

Every matter consists of particles like electrons or photons. For scientists to understand more about the world, they want to measure particles and study their speed.

But, when you attempt to study particles, they do something really bizarre. Strangely, the more accurately you attempt to measure the position of a particle, the more unclear its speed gets; and the more precisely its speed is measured, the less definite its position gets! This occurrence was first found out during the 1920s, and it is known as the uncertainty principle.

Due to the uncertainty principle, scientists needed to use other means of examining particles; therefore, they started to examine a particle's quantum state rather. Quantum state joins together a lot of possible positions and speeds of a particle.

Because scientists cannot find a particle's definite position or velocity, they examine the various possible positions particles might take and velocities they might possess. As a particle moves around, scientists monitor the entire possible positions it could be and choose which of these is the most possible.

To assist them to know this, scientists view particles like waves.

The number of various positions that a particle might be signifies that they occur like a range of continuous, oscillating waves. Think of a piece of vibrating string. When the string vibrates, it will arc and dip through peaks and troughs. Also, a particle acts like that this, though its possible direction is a range of such overlapping waves, all occurring at the same time.

Examining particles like that assists scientists determine the most likely position of a particle. The most possible positions of the particle happen where the arcs and dips on the various waves match with one another, and the least likely positions are where they don't correspond with each other. This is known as interference, and it reveals which positions and speeds are most likely for the particle wave's direction.

## Chapter 6 - Gravity is the outcome of huge objects curving the world.

When you check the world that surrounds you, you are viewing it in three dimensions, i.e., you can explain any object by its depth, width, and height. Still, there is another fourth dimension, though we can't view this ourselves: the fourth dimension is time, and it adds with the other three dimensions to create known as called space-time.

Scientists make use of this four-dimensional model of space-time to explain events in the world. An event is a thing that happens at a specific position in space and time. Therefore, when measuring an event's position together with the three-dimensional coordinates, scientists include a fourth coordinate to determine the time.

Scientists need to put time into consideration when identifying the position of an event since the theory of relativity postulates that time is relative. So, it is a significant aspect in explaining the nature of an event.

A remarkable effect of merging space and time is how it transformed our notion of gravity.

Gravity happens as a consequence of huge objects curving space-time. An enormous mass, such as that of our sun, curves and really changes space-time. Consider it like this: Envision space-time to be a like a blanket stretched and held in the air. If you put an object at the center of the blanket, the blanket will curve and the object put in the middle of the blanket will sink a bit. This is the thing huge objects do to space-time.

The other objects then go with these curves in space-time. The reason is that an object usually goes to the shortest route between two points, and that is a circular orbit around a bigger object. This can be seen if you check that blanket one again. If you place a big object such as an orange on the blanket and then attempt to roll a smaller one –for instance, a marble – past it, the marble will go after the indentation made by the orange. Gravity works like that too!

## Chapter 7 - When a star with a really high mass perishes, it falls into a singularity known as a black hole.

During the lives of stars, they require huge quantities of energy to release heat and light. Still, this energy doesn't even last long; ultimately, it finishes, making the star to die.

What occurs to a star after its death rests on its extent. When the energy of a really huge star finishes, something remarkable is formed: a black hole.

A black hole happens due to the fact that the gravitational field of most huge stars is really strong. While the star is still living, it can to use its energy to save itself from falling. However, when the star energy finishes, it cannot defeat the gravity anymore and its decaying body falls in on itself. The whole thing is pulled inwards toward an extremely dense, spherical point known as a singularity.

This singularity is called the black hole.

When the black hole appears, space-time is curved really steeply by its gravity and even the light curves together with it.

A black hole doesn't just pull in all the things that are close by; however, it also averts anything that crosses a specific limit around it from evading again: this point of no return is known as the event horizon, and even light, which travels really faster than any other thing in the work, can escape back over it.

This brings up a question: if a black hole can absorb light and any other things that cross its event horizon, how can we recognize that they are present there?

Scientists look for black holes by checking for their gravitational effect on the world and for the X-rays created by their relations with orbiting stars.

For instance, scientists check for stars orbiting dark and huge objects that could be black holes.

Also, they check for the X-rays and other waves that are usually created by matter when it is being sucked in and destroyed by a black hole. Also, in the middle of our galaxy, we have a source of radio and infrared waves that could be an extremely huge black hole.

## Chapter 8 - Black holes release radiation, which can cause their death through evaporation.

Since the gravitational pull of a black hole is really powerful that even light cannot get out from it, then you'd probably assume that nothing can escape from it as well.

However, you'd be incorrect. As a matter of fact, black holes have to emit something; or else, they'd violate the second law of thermodynamics.

The universal second law of thermodynamics asserts that entropy, which is the propensity toward bigger disorder, continuously increases. Also, as entropy increases, the temperature as



well needs to increase. An illustration of this is the manner in which a fire-poker, after being in a fire, radiates red-hot and emits radiation as heat.

As stated by the second law, because black holes suck in disordered energy from the world, the entropy of the black hole has to increase as well. Also, because of this increase in entropy, black holes need to allow heat escape.

It is possible for heat to escape since, even though anything that has passed a black hole's event horizon cannot escape, virtual pairs of particles and antiparticles close to the event horizon maintain the second law of thermodynamics. Particles that cannot be seen; however, whose effects can be measured is known as Virtual particles. One of the pairs of particles possess positive energy and the other has negative energy.

Gravitation is really powerful in a black hole that it can suck the negative particle into the black hole and by doing that give its particle partner sufficient energy to likely escape into the world and be released as heat. This enables the black hole to release radiation, and therefore follow the second law of thermodynamics.

The quantity of positive radiation released is balanced by the negative particles that are sucked into the black hole. This inward flow of negative particles can make the black hole's size decrease until it ultimately evaporates and dies. Also, if its mass becomes really small, the black hole will probably end in a huge final explosion, as if as millions of H-bombs.

## Chapter 9 - Though we can't be certain, there are strong indicators that indicate that time can merely move forward.

Think of a case where the world started to contract and time began running backward. How would that be? Maybe clocks would move backward and the course of history would be backward. Scientists haven't totally eliminated it; however, there are three strong indicators that indicate time merely moves forward.

The thermodynamic arrow of time is the first indicator indicating that the passage of time moves from past to future. According to entropy which is the second law of thermodynamics– the disorder of a closed system – has a tendency to increase with time. This entails that time can be measured by the propensity of disorder to increase.

For instance, if a cup falls from a table and breaks, it has become less ordered, and its entropy has increased. Because a cup that is broken would never automatically join back together again and increase its order, we get that time is just moving forward.

Parts of the second indicator of forward time is the broken cup and the thermodynamic arrow of time: the psychological arrow of time, which is managed by memory. You can recall the cup being on the table after it has broken; however, before it broke, when it was still on the table, you can't "recall" its future spot on the floor.

The cosmological arrow of time which is the third indicator means the expansion of the world and this as well follows along with our view of the thermodynamic arrow of time. The reason is that as the world expands, entropy increases.

Assuming the disorder in the world got to its highest point then the world could begin to contract, which would then reverse the cosmological arrow of time. But, we wouldn't understand it since intelligent beings can merely occur as disorder increases. This is the reason why we depend on the process of entropy to break down our food into energy.

So, provided that we are still in existence, we will notice the cosmological arrow of time as moving forward.

## Chapter 10 - Besides gravity, there are other three fundamental forces in the world.

What types of forces are working in the world?

The majority of the people will have probably heard of just one: gravity which is the force that attracts objects to each other and it is felt in the manner that Earth's gravity pulls us to its surface.

But, the majority of the people are not aware that there are really three other forces that act on the tiniest particles.

The electromagnetic force is the first force, which can be seen in normal life when a magnet sticks to a refrigerator or when you charge your mobile cell phone. It acts on every particle that has electric charges, like electrons and quarks.

The electromagnetic force, just like the north and south poles on a magnet, can be repulsive or attractive: particles that are positively charged attract negative particles and repel other positive particles and the other way round. This force is very powerful than gravity and rules at the small level of the atom. For instance, the electromagnetic force makes an electron to orbit around the atom's nucleus.

The weak nuclear force is the other force, which acts on every particle that constitutes of matter and which leads to radioactivity. This force is known as "weak" since the particles that hold it can only use force at short distances.

The strength of the weak nuclear force at higher energy increases until it fits with that of the electromagnetic force.

The last other force is a strong nuclear force, which joins protons and neutrons in the nucleus of an atom, and joins the lesser quarks within protons and neutrons. Different from the electromagnetic force and weak nuclear force, the strong nuclear force becomes weaker at higher energies.

At really high energy known as grand unification energy, the weak nuclear force and electromagnetic force become stronger and strong nuclear force becomes weaker. At that moment, the entire forces get to an equal strength and become separate parts of a single force: a force that might have had a big part to play in the formation of the work.

## Chapter 11 - Even though scientists think that the world began with the big bang, they are uncertain of precisely how this occurred.

The majority of the scientists think that time started with the big bang – the point when the world changed from an infinitely dense state to a fast-growing entity that is still developing even as at now.

But scientists don't understand precisely how this big bang happened; however, several theories have been stated to demonstrate how this big development might have occurred.

The most famous accepted theory of how the world started is the hot big bang model.

According to the big bang theory, the world began with no sizes and was extremely hot and dense. But, during the big bang, it grew, and as it developed its temperature cooled as its heat was spread. During the first few hours of this growth, the majority of the elements we have in the world now were formed.

As the world kept to grow, gravity made denser areas of the expanding matter to begin rotating, forming galaxies. In these new founding galaxies, clouds of hydrogen and helium gases collapsed. Their atoms that collided lead to nuclear fusion reactions, which formed the stars.

After the deaths of these stars and after the star collapsed, they formed massive stellar explosions that emitted more elements into the world. This gave the substance for the creation of new stars and planets.

Though this is the commonly accepted description of the big bang and the emergence of time, this isn't the only model that is present.

A different model is an inflationary model. This model states that the energy of the first world was really extremely high that the strengths of the electromagnetic force, the strong nuclear and weak nuclear force were the same.

But, as the world grew, the three forces took on different strengths really fast. As the forces divided, a huge amount of energy was emitted. This would have had an anti-gravitational consequence, making the work to grow very fast, and at an increasing rate.

## Chapter 12 - The general relativity and quantum physics haven't been combined yet by physicists.

In their wish to know and explain the world, scientists have formed two main theories. The first theory is general relativity, which focuses on a really big phenomenon in the world: gravity. The second theory is quantum physics, which explains some of the tiniest identified objects in the world: particles smaller than atoms.

Although both of these theories offer great understandings, there are huge differences in what is predicted with the equations of quantum physics, and what is predicted and observed with general relativity. This signifies that presently there is no technique of joining them together to make one whole unified theory of everything.

One problem that hinders the two theories from being combined together is that a lot of the equations scientists make use of in quantum physics bring about apparently impossible infinite values. For instance, from the equations, the curve of space-time would be infinite, which is something observations have proven to be wrong.

In order to nullify these infinities, scientists attempt to bring in other infinities into the equation. Unluckily, this hinders scientists from being able to predict correctly. Due to this, rather than making use of the equations from quantum physics to predict events, the events themselves need to be included and the equations twisted to make them appropriate!

A second, related issue is that quantum theory proposes that the entire empty space in the world consists of virtual pairs of particles and antiparticles.

But, the existence of these virtual pairs brings about problems for general relativity.

Because there is a countless amount of empty space in the world, the energy of these pairs would need to have infinite energy.

This is challenging since Einstein's popular equation  $E=mc^2$  proposes that the mass of an object is equal to the energy of the object. Therefore, the infinite energy of these virtual particles would entail that they also possess infinite mass. Also, if we had infinite mass, then the entire world would ruin under the extreme gravitational pull and turn into a single black hole.

## A Brief History of Time by Stephen Hawking Book Review

A lot of people have put off physics since they view it as an impenetrable world of long equations and difficult theories. And, to some extent, this is correct. However, the difficulty of physics shouldn't hinder us non-experts from knowing how and why the world functions.

There are a number of laws and rules that assist us to know the mysteries of the world that surrounds us. Rules and laws that the majority of people can understand. And as soon as we know them, we can start to view the world in a new way.

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