

CO500: Informative Speech

Einstein and Heisenberg

or

Relativity and Uncertainty

A. Introduction

My Speech is about the scientists who had the main influence on our current time and have shaped our contemporary view of the world (Also called in Theology the "Zeitgeist").

I have chosen two of them who were in many ways just opposites. One is extremely famous and the other is almost unknown except to specialists. The most famous is of course Albert Einstein. He has significantly altered our view of the world with his Theory of Relativity.

The other one is not so well known, his works are commonly associated with Einstein instead.

His name is Heisenberg. He worked mainly in Quantum Physics and was responsible for the development of the Principle of Uncertainty. This is one of the topics of this speech.

Incidentally both are German like I am. Their lives were shaped by the confrontation with Nazi-Germany. Einstein was Jewish and left in 1933 when Hitler came to power. Heisenberg tried to compromise with the Nazis and make the best (whatever that was) out of it. During the war both were active on different sides in the race for the development of the Atomic Bomb.

That's surely one of the reasons Heisenberg is not so well known.

I think it is important to understand their ideas because they have had a great effect on our present society. We will better understand our present society by knowing a little bit about them.

Many have tried to explain what these Theories mean and there has been a lot of Hype about it. Most do not understand what this is all about. So let's make a survey! The very interesting thing is that there are a lot of elements in these Theories which are important for our beliefs and thereby also our Faith!

B. Einstein and his Theory of Relativity

Einstein was a very rebellious young man. Teachers complained about him that he would not learn anything that they asked him to. He would just learn what interested him. He spent hours with thought experiments like how would it be to ride on a beam of light?

This sounds very foolish and naturally many people at that time thought the same. But it had a concrete background in the scientific circles of the later 19th century. They had begun to measure the speed of light and that is where it all started.

But to understand the issue we have to go back a bit to Issac Newtown who was revolutionary scientist and discovered the law of gravity and the basics of the laws of physics. These were not revolutionary, but revolutionary was the ability to get a mathematical grasp on it so they could calculate.

Newtown made it possible to calculate the path of a bullet. Very important for the military.

He made an interesting observation. When you take a ball in your hand and throw it, the ball will have a certain speed while it is moving away from you. But if you see somebody in a train throwing a ball the speed of the ball adds up to the speed of the train. This does not seem to be the case if you are yourself in the train throwing that ball. The ball moves away with the same speed as it did when you performed the same thing on the earth.

The Speed of the ball is dependant on the viewpoint. Depends from where you measure it. This is a kind of Newtownian Relativity. The speed of an observed incident - like a flying ball - depends on your own speed.

If you are throwing it while standing firmly on the earth, the ball just has - well the speed with which you are throwing it. But if you a train coming by and you see somebody inside throwing a ball in the direction of the movement of the train, what is the speed of the ball for you?

Of course the speed of the train plus the speed with which a person threw the ball.

This means the measure of speed is relative to the speed of the one observing.

Science got puzzled when they started to measure the speed of light. They measured it at 186,000 miles per second. At that speed light will travel in 1.5 seconds from the Earth to the Moon a distance of 240,000 miles. 670 million miles per hour.

Then the scientists began to measure the speed of light from a distant star.

The Earth rotates around the sun with a speed of 18 miles per second. This means that there is a time in the year - one full rotation of the earth around the sun - when the earth is moving away from the star with 18 miles per second and another time when the earth is moving towards the star with 18 miles per second. The first problem was the inaccuracy of their instruments. It is very difficult to detect a variation of 18 m.p.s when one is working with thousands of m.p.s. Finally they succeeded, but the results were always the same. The Speed of light never varied. If light would behave as according to the laws of nature as set up by Newton, then the speed must be dependant on our speed relative to that star.

This is very important to note, because this is the starting point of Einsteins genial thoughts.

The basis of his theory of relativity is an absolute. The speed of light never changes.

No one had dared to assume such an absolute idea before him. To every earnest scientist this assumption was plainly in error. Newton had proven that speeds are dependant on the movement of the observer.

Einstein claims that the speed of light is an exception. The speed of light is always the same whatever the current movement of the observer.

To return to the example with the train. This means if you stand on the ground and switch on the flashlight, the speed of the light from that flashlight will be 186,000 m.p.s. If you see a train coming by and switching on its headlamps, the speed of that light will be 186,000 m.p.s from your position. It does not matter what the speed of the train is, the speed of light from its headlights will always be 186,000 m.p.s

Einsteins theory of Relativity is based on the absolute unchanging speed of light!

From this starting point Einstein developed a new understanding of reality. All of reality is relative to the absolute which is the speed of light. This means that from different observers moving with different speeds and therefore different frames of reference (that was his term) the universe will be seen different in its shape and time.

The nearer the speeds of objects come to the speed of light the more the universe will be distorted.

Results of the theory show that objects moving at such high speeds will experience a contraction in the direction of movement. Their mass will increase. And time will run slower.

Since the mass of an object increases exponentially the nearer it comes to the speed of light no object can ever reach that speed. And never will anything be able to travel with more than 186,000 m.p.s since this would mean that the object would have an infinite mass.

Sorry to all Science-Fiction fans out there. This is not possible according to Einsteins theory of Relativity.

The old Newtonian Model is a special case of the Theory of Relativity. When everything is moving at slow speeds everything behaves as we already knew before.

Einsteins first step was the Theory of Special Relativity. Special Relativity is only concerned with objects that are not accelerating but moving at constant speeds toward each other.

Einsteins later Theory of General Relativity also includes objects that are accelerating relative to each other.

Special relativity is much simpler than General Relativity. Most discussions are only concerned with Special Relativity. It is said that there is no one who really understand General Relativity.

It is important to understand that Relativity for Einstein does not mean everything is just fluid and.

Relativity means that the behaviour of moving objects is exactly predictable and therefore deterministic.

There is no sort of freedom in this Theory. All implications that are drawn for everyday life or ethics like the common saying - everything is relative - are pure nonsense and have nothing to do with this Theory. If we would use "relative" in the sense of Einstein, and would then say "Everything is relative" we would

mean that everything is under our control, we have a mathematic formular for it, it is not that it is just fluid!

C. Heisenberg and the Principle of Uncertainty

Einstein later tried to develop another theory to explain Quantum Mechanics. Quantum Mechanics is concerned with the behaviour of small particles like the Electrons, Protons and Neutrons. These are the basic building blocks of all matter. Again there were some strange phenomena observed which required the development of a new view of reality.

The first of these was the question if light was a wave or a particle.

A wave is something like what is happening when you throw a stone into a waters. Waves emerge. If there is more than one of these waves at the same time they will interfere with each other. Waves need a medium - here water - in which they can function.

A particle is like something concrete. To be concrete like a stone or a bullet. A particle does not cause a wave and does not build up interferences with another, except when it directly hits some other particle. Think of it as two stones. They wont bother each other unless one his the other.

There was a dispute going on if light is working like a particle or like a wave. Until 1921 it was commonly held that light is a wave in a medium which was unknown and was commonly called the ether. Thats the water for light.

Einstein proposed in 1905 that light could also behave like a participle and called it a light-quantum.

He found that if you "shoot" light at a electrically charged plate it would knock out electrons. This could only be done by particles not by waves.

Things got even worse when it was discovered that light could behave sometimes like a wave and sometimes like a particle. Light would switch from one kind of behaviour to the other, according what the scientist wanted to detect. Would the scientist in an experiement attempt to localize a particle (Electron - electric particle or Photon - light particle -) then it would behave like a particle.

Would the scientist in an experiment attempt to measure interference then it would build up interference.

Of course this was something that drove science nuts. How can light change its behaviour depending on the survey done?

To make things clear a famous test was done. A Photon gun was developed which would shoot one photon at a time on a screen. That way the behaviour of the photon would be observable. To make the observance of interference possible another blockade with two holes for exactly one photon was placed between screen and photon gun. A photon shot would go through one of the two holes and project an image on the screen.

When a series of photons were shot, the photons arrived on the screen in a pattern of interference.

This alone was astonishing. It meant that one photon could interfere with itself! The path of one photon through the holes was not predictable. There was a certain probability where it would arrive to build the pattern of interference, but there was no way to exactly predict where it would go.

There was no causality only a probability where it would go.

Now the interesting question was through which of the holes did the photons travel?

Two detectors were fixed on the holes and sometimes the photons choose one hole and sometimes the other.

Again it was not predictable which hole they would choose.

Excellent, but now the interference on the screen was gone! The photons went straight through to two points (one for each hole on the screen) and did not interfere with themselves anymore. If the detectors would be switched off the interference they would be there again!

Based on these behaviours Heisenberg formulated his Principle of Uncertainty.

He said that only certain features of a particle can be observed.

Either one can observe where the particle is, then nothing can be known about the direction and speed of its travel, or it can be observed how the particle is moving, but nothing can be known about where the particle actually is.

Einstein fought for 30 years against Heisenberg's Uncertainty Principle. At the end Heisenberg's Uncertainty Principle persisted. Einstein's major complaint to Heisenberg's theory was "God does not throw dice".

The Principle of Uncertainty means that the intrinsic workings of particles cannot be fully observed. The smallest parts do not conform to any causality. There is no reason why they would behave in a certain way. They just do. Only empirical surveys of their behaviour can be done.

This also in turn affects all our other "laws" of nature we have. All of these are empirical, these signify most probable behaviour of our world. There is no way of knowing what exactly will happen even if all circumstances are known. The Cause and Effect relationship on which science is built is only valid as an empirical result.

This was very hard for scientists to accept. No wonder that Einstein objected "God does not throw dice".

D. Finish

I want to close with a final Citation from Ecclesiastes, which basically says the same:

When I applied my mind to know wisdom, and to see the business that is done on earth, how one's eyes see sleep neither day nor night, then I saw all the work of God, that no one can find out what is happening under the sun. However much they may toil in seeking, they will not find it out; even though those who are wise claim to know, they cannot find it out. (Ecc 8:16-17 (NRSV))

Resources

Bible Quotation : NRSV (New Revised Standard Version)

Cassidy, David Charles "*Uncertainty: the life and science of Werner Heisenberg*", New York 1992, W.H. Freeman and Company

Friedman, Alan J. and Carol C. Donley "*Einstein As Myth and Muse*" Cambridge 1985, Cambridge University Press.