

Research Methodology
Prof. Soumitro Banerjee
Department of Physical Sciences
Indian Institute of Science Education and Research, Kolkata

Lecture - 14
Historical Perspective: Emergence of Materialism and Idealism Part 02

Let us just take a quick look at what I described. In the early Greek period, it was materialistic thinking, but subjective. At some point of time there was onset of idealism – idealism of the form that idea is prior, matter is secondary. And there was the subjective mode of thinking—whatever you can think of, that is the truth for you.

A lot of belief systems sprouted. In the Middle Age, one kind of belief system became mainstream. So, the middle age can be said to be the golden age of idealism. You would notice that, in that golden age of idealism spanning over a thousand years, there was practically no science. Science died down, because the thought process was ‘belief and no question’.

In the 15th-16th century, things started changing. Even though trade and commerce was low, there were some trade and commerce—in the main for the sake of the aristocrats, for the sake of the land owners, because they needed aristocratic goods.

So, there were some exchanges, some trade, and the traders over the centuries were slowly becoming financially more powerful. So far they were simply buying from one place and selling it another. They were buying from say India spices and selling it in Europe; they were buying wherever cloth is produced and selling it to another place; they were buying some exotic food stuff from one place and selling it another; glassware, ironware and all these were subjects of trade.

In the 14th-15th century, they started to manufacture these things. They started what were called ‘manufactories’, where normal people, the people who would otherwise be engaged in tilling the land, when they were free, they would come and make something for the trader: something made of iron, something made of glass, something made of cloth. These manufactories increased the volume of production and slowly these people, the traders, become financially powerful. That brought in a disbalance in the kind of society that existed.

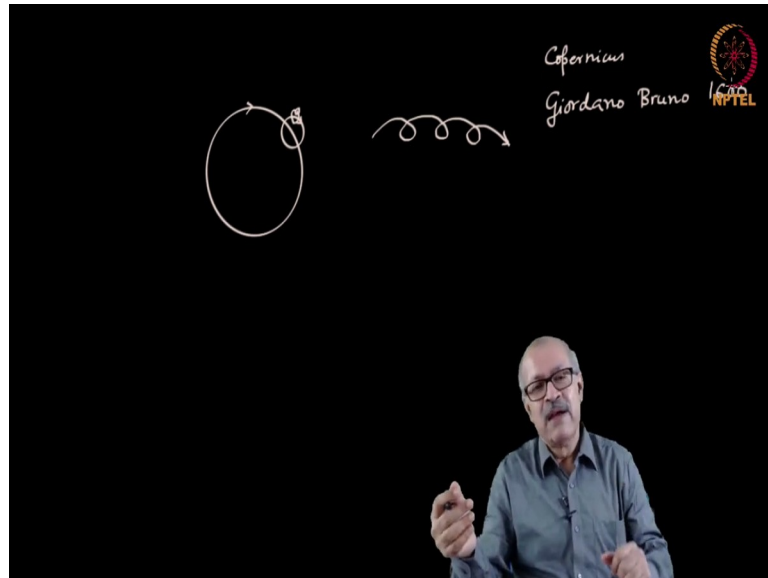
Earlier the aristocrats and the land owners were calling the shots; but now the moneyed people, the traders in the main, they became relatively more powerful. And in that stage, we see in the cultural sphere, the birth of a new kind of movement called Renaissance. Renaissance actually questioned everything.

People were questioning whatever were believed so far. Earlier God was at the center of everything. All paintings were centered around God and humans were sort of appendages in the paintings. But now humans became the center of all paintings. Look at the Sistine Chapel painting by Michelangelo; even Jesus is painted as a powerful man, that otherworldly features are gone, a powerful man.

People started depicting man as the center of everything. Thus, the center of attention came to humans. In that stage, in science, a lot of developments happened. Copernicus took a look at the models of the solar system that were in existence. I said that one model of a of solar system was where the planets move as embedded on crystal spheres. Another picture was the Ptolemaic picture, where the planets moved in epicycles.

As people took more and more closer look at the planets' motion, they found that these are not being explained by the epicycle picture. So far the idea was that the orbit of a planet would be circle over circle and naturally the orbit of the planet would be something like this as visible from the Earth. But people were observing the actual motion of the planets and they could not explain it with this picture. Then they thought that there may be epicycles over epicycles, over epicycles, over epicycles so on and so forth. And the picture of the solar system became very complicated.

(Refer Slide Time: 05:08)



In this status, Copernicus saw that there can be an alternative model of the solar system not with the Earth at the center, but with the sun at the center. And sun at the center and the planets going around it, the Earth is also seen as a planet and the moon is going around the earth; so that was the picture painted by Copernicus.

He knew that his views will be considered heretic and so, he allowed publication of his book only when he was in the death bed. But his book, after it was published, was banned from most of Europe. But banning was not very effective in those days, because copies remained here and there in different people's possession and in libraries.

This man Giordano Bruno, who was training to become a monk, saw such a copy in one church library, read it, and was convinced. And he took it upon himself to propagate that idea among others. So, Giordano Bruno accepted what Copernicus had to say, he was convinced that it was true and he took it upon himself to propagate that view.

He understood that he cannot do that being in Italy; because it was in the grip of the church rule. So, he fled Italy, went to other countries in Europe; went to Paris, went to Germany, went to England and from everywhere he was expelled. The more he preached his ideas, he was thrown out, he was driven out. Not only did he believe in the Copernican picture of the solar system, he believed that the stars that we see, these are also like suns, and like the sun they also have planetary systems around them and they might also harbour life. So, the Earth is not the only abode of life and that.

These were all heretic ideas in the view of the church at that time. Finally, the church caught him and after years of torture trying to get him to accept the church view, to recant his own views, he refused. Finally, in the year 1600, he was burned at stake in Rome.

At that time Galileo Galilei was teaching in the University of Pisa when Bruno was burned. He was having to teach what was the established belief at that time. Especially in mechanics the belief was, according to Aristotle, force produces motion. According to Aristotle, a heavier body will fall faster than a lighter body. And while teaching these, the only difference was that, Galileo said 'let us go and test it'.

So, as per legend, he took his students and went up the leaning tower of Pisa and dropped one heavy mass of iron and one small mass of iron and they came down together with the same sound. And that demonstrated that the earlier belief was wrong.

Most importantly, it brought in a very important philosophical current: *objective thinking*, which said that what I am thinking, what I am believing, what I am having to teach may be wrong. Therefore, it is my task to test it against physical reality.

He also tested these things by rolling balls on inclined planes and he did experiments on pendulums and through that, he established that actually force does not produce motion; force produces *change in motion*, which was later adopted by Newton to produce his first law of motion. Galileo also built a telescope and looked at the sky for the first time. And when he looked at the sky, he saw spots on the sun, he saw mountains on the moon, he saw phases of Venus, he saw satellites of Jupiter and so on and so forth.

Now, out of these, there were two important observations. One was the phases of Venus. Phase means, the way the moon goes through phases—new moon, full moon, half-moon—that way Venus also goes through phases. And Galileo realized that, that can happen only if Copernicus' idea is true, Copernican model is true, and only if Venus is an interior planet, then only it is possible to have phases of a planet.

And he also saw the satellites of Jupiter and realized that, if some satellite is moving around that planet, there cannot be a crystal sphere there. So, the crystal sphere idea was immediately proved wrong.

He invited his colleagues of the university to look through his telescope to check what he was saying. They refused. They said that the telescope is the problem. Whatever has been believed is to be believed and the telescope is a problem.

He went into trouble with the church, I am not going into the details. Finally, he was called to the 'inquisition' as it was called. Those who did something that is heretic, they would be called by the inquisition, there would be a trial and finally, there will be punishment. And the old man was punished for the rest of his life in home imprisonment.

But during that period he wrote up his ideas in form of books and somehow managed to get these out and his disciples took it to Holland, which was at that time protestant and not all that much in the Church's control. The books were published from there and people came to know about his ideas. Through that the horizon opened.

At the time something else was happening. Tycho Brahe was looking at the motion of planets very accurately; he made an observatory in an island off the Holland coast, called Uraniborg and he was making very accurate observations. But at some point of time he fell out with a king, he was driven out from there, he again got shelter with another king in Austria, built another observatory.

At that time, a young man Johannes Kepler, became his assistant and within a year Tycho Brahe died. When Tycho Brahe died, all his gathered mass of data regarding the motion of the planets came to the possession of Kepler.

He sat down with it and tried to work out the motion of the planets for a long time and then he came up with the Kepler's laws; that planets move in ellipses and what you know as Kepler's laws: that they subtend equal areas in equal time and so on and so forth.

So, with that, the Renaissance was in full swing. And in the next stage, we will see a great development. The moment the mental roadblock: 'believe and do not question' was removed, people started questioning and not believing.

And then they started looking at the whole world anew and that is when the science proper started. That is why the onset of scientific era is said to be from the time of Galileo. Why? Because Galileo introduced the objective method of thinking.