**Sociology of Science**
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**Lecture – 13**
**Structure of Scientific Revolutions: Thomas Kuhn – Part II**

Dear students, now, we are discussing the structure of scientific revolutions by Thoman Kuhn. Thomas Kuhn is a historian of science. In fact, took a degree in physics, he is a PhD in physics from Harvard university, but during his undergraduate days, he was exposed to classic literature and science, because he was told to teach a science course to the non science students as a graduate fellow, and that got him interested in the field of history of science, and this is says in the second edition to his monumental book, the structure of scientific revolutions.

Now, the second edition came in 1970 and the preface to that he mentions that how he started taking interest in the classic literature and science and he found that many of the things that were argued or models that were suggested, if you look at a data and theory that was available you know, instruments the method that was available during that time.

It was alright, it was completely acceptable and this given, this idea of paradigm and paradigm shift. In the previous lecture, I also gave example from chemistry, I gave example from astronomy and Ptolemy versus Copernicus debate, that in chemistry initially alcohol and water was considered to be a combination of that consider to be a compound, because it could be, it could not separate completely, and it could be mixed in any proportion, but given the data set given the ideas and models that were available in 18th century.

It was perfectly acceptable, but the paradigm shift came when Dalton atom theory came into being who says, that the atoms can only be combined in whole number ratio or let us look at the argument of Ptolemy that all these are at the center of the universe, but Copernicus, he said that no, he said sun is at the end center of the universe, but he made use of the cycles and epicycles, the geometric models of a planetary motion of Ptolemy to prove his point, but he did not succeed.

His calculations were not accurate. Hence, his thesis was discredited. Thomas Kuhn says, that is perfectly all right.

Only when Galileo made some further argument regarding matter and motion then, which was taken forward by Kepler, finally, it was Newton through his theory, he proved a certain rudimentary theories, in science regarding matter and motion, which is accepted. Now, only then a scientific paradigm could be possible, scientific parad shift and scientific paradigm could be possible from Ptolemaic model till Newtonian model, in nineteenth century. Eighteenth century science, what is Thomas Kuhn's idea? He says, I am presenting a view of science, a history of science in a non-linear fashion, he argues the science, scientific progress paradigm shift. It does not take a linear direction, it is not cumulation; it is a revolution. Hence, he has named his book structure of scientific revolutions, he says from time to time there is no fixity to that, but every now and then in every field of science.

There has always been a paradigm shift, which he calls a scientific revolution and this is a revolution, not accumulation. It is not a linear progression, science does not progress in a linear fashion, science progresses through, breaks through discontinuous, discontinuities through revolutions and this is what we are discussing in the concluding part of this lecture on Thomas Kuhn structure of scientific revolutions.

How does that happen, we have already discussed in the previous lecture that a paradigm is one, which is a dominant scientific worldview. It became emerges as the dominant scientific worldview, out of many other scientific worldviews and it becomes accepted, because it is better at explaining the natural or social phenomenon at hand. Hence, it gets more supporters practitioners of science, these scientists, who working within the scientific community.

Hence, it becomes a dominant paradigm, once it becomes the dominant paradigm then begins the normal science activity. Normal science activity is the day to day research of scientists, where they do research, this choose problem, they solve their problems they use and choose technology method. According, to the scientific worldview within which they operate, within the paradigm, for Thomas Kuhn research is nothing, but an attempt to feel research detail to certain conceptual boxes to force nature into conceptual boxes.

You explain the natural phenomenon and you interpret it within the existing paradigm, within the conceptual notions, conceptual models, theoretical outlines provided by the scientific paradigm. Hence, you are forcing nature into certain conceptual boxes, research is nothing, but puzzle solving activity, where you have a predetermined end. You know what is to expect, we are going in that direction to get the expected result. So, normal science activity does not have novelty or newness comes in when you encounter anomaly. What is anomaly?

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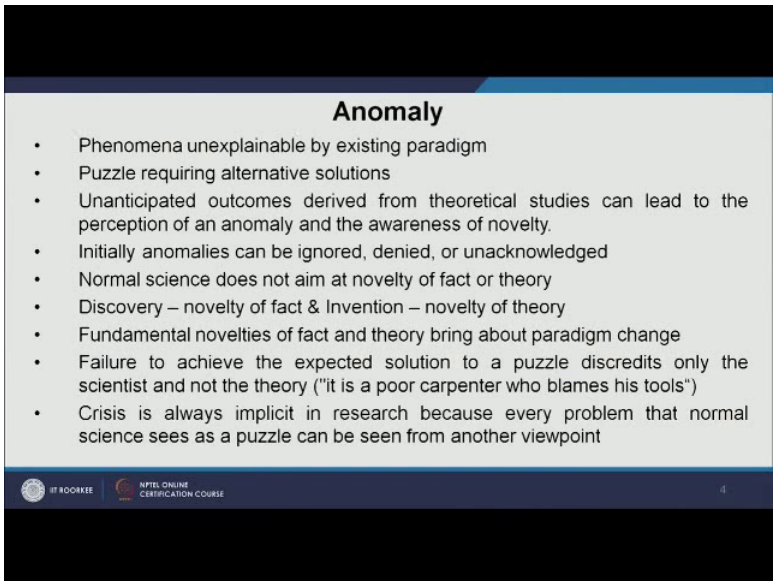


Anomaly occurs when a particular scientific phenomenon cannot be explained by the existing paradigm, as a scientist or researcher working on a problem, comes up with a finding, arrives at certain results which is not in sync, with not in tune, with the dominant paradigm that is when; if anomaly is detected, when a puzzle requires an alternative solution, when you try to solve a problem you cannot solve it.

Making use of the existing technology means existing methodology, existing conceptual tools, you need an alternative as separate, a different way of looking at the same thing that is when an anomaly occurs, unanticipated outcomes come to light, which can lead to perception of an anomaly and the awareness of novelty when outcomes are unanticipated generally, puzzle solving activity, within the normal science, what is that? That is you are anticipating results, but when you get unanticipated result, unanticipated outcome, then it

may lead to a perception of an anomaly, but initially anomalies can be ignored, denied or unacknowledged.

You see, if you come up with something new, initially nobody would accept that they would say that there is something wrong with our method, there is something wrong with the data, something wrong with your experiment, initially a new thing, would not get accepted easily. It will be ignored, you will be told the reviewer of your article in journal, would tell you to go back and review the method, please review your data, please cross check your data, maybe there is something wrong, but whatever you are arguing, it is not in sync with the dominant existing paradigm.

So, initially the scientist, who come up with something new will get rejection, will face rejection, will be denied of the originality of the thesis, a normal science. Essentially, does not aim at novelty of fact or theory, it does not aim at the newness of fact or theory and that is one jargon that Thomas Kuhn uses here, that is discovery for him is novelty of fact and invention for him is novelty of theory.

Newness in theory is invention, newness of fact for him is discovery fundamental dis novelties of fact and theory bring about paradigm change, when there is fundamental change in the fact and theory, there is complete newness in the fact and theory, only then a paradigm shift occurs. Now, when you come up with something new, initially within the normal science, when you are working within the scientific paradigm, the new results would be discredited. It will be like is a poor carpenter, who blames his tools.

So, if you do not come up with something which is expected, then there is something wrong with your tool, something wrong with our method, something wrong with your instrument, something wrong with a data set, something wrong with the way you did the experiment right now, but crisis is always implicit in research, because every problem that normal science sees, as a puzzle can be seen from another point of view, but crisis is looming in every field of science here, crisis implies some, you come up with a result which does not meet the expectation initially, it will be ignored, but time comes when it can no longer be taken lightly.

It has to be taken seriously when not single not individual, but a group of scientist in

different places all over the world come up with different findings, which does not conform to the dominant scientific paradigm and anomaly can call into question fundamental generalization of the paradigm, it always questions.

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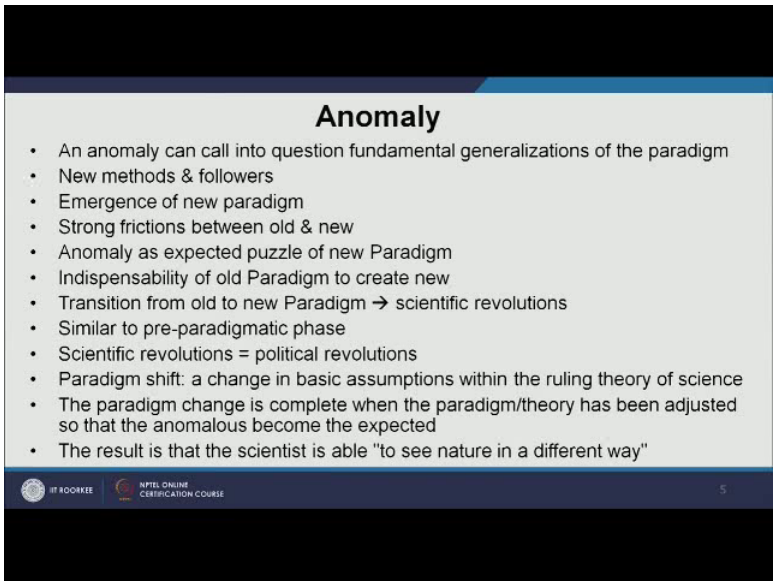


And anomaly will always question the fundamentals of the existing paradigm. It will always talk about a new method of going about research and will always have a new set of followers and that will lead to the emergence of a new paradigm. They will always be friction conflict between the advocates of the older paradigm and advocates of the new paradigm. Now, this transition from the old to the new paradigm is not easy, it is not simple. In fact, Thomas Kuhn compares the trend paradigm, shift in science or in other words he compares the paradigm shift in science to political revolutions. He compares political revolution and scientific revolutions.

He says just the way political revolutions come about in any political system, in any society, in any country. Similarly, scientific revolutions come in any society, in any scientific community. How does he compare academic scientific revolutions with political revolutions, with the help of his idea of paradigm shift and scientific revolution? He says, initially when anomalies appear, it is discredited, when people report new findings, new results, it is not taken seriously, but this scientists, just like in political revolution initially, there will always be a few people who would raise, protest against the pollute, existing

political framework against the existing political institution, against the existing political governance system.

There will be sporadic protests, scattered protests here, and there maybe, it will get some newspaper coverage, maybe you will get some coverage in a magazine, maybe we will get reported in internet that is it, but slowly when the protest dissatisfaction with the current political structure grows, there will be more protests, there will be more reporting of such protests in media, it can take the form such protests can take the form of strikes. General strikes can be mass protests in the street initially and such mass protests, such general strikes would be suppressed, would be repressed by the political system, but a time comes when the mass protest is difficult to manage and then those people who are supporters of the existing political system and those who are advocating a new political system, a new governance structure, they come in direct conflict.

There will be a series of negotiations, bargaining, whether people who support the existing political system, they will defend it and those who want a new political system, who are unhappy, dissatisfied with the existing political system, they will ask for a new governance system, new rule of law. Finally, in that transitional phase as the supporters of the new political system grows slowly, they will overtake the political system and in the transitional period, there will be a little bit of chaos in any country's politics and soon the group of people, who are the adherents of the new political system, they will sees power and continue their political dominance.

This is how it happens in scientific revolutions as well. According to Thomas Kuhn initially, there will be anomalies that will be ignored, but as anomalies grow the advocates of the new theory, new methods rise in number, then there will be a period where the group of scientists, who subscribe to the old paradigm and growing number of scientists, who subscribe to the new paradigm, finally, the new paradigm becomes the dominant paradigm and it remains in the dominant position, till further anomalies come and then a new revolution begins.

Hence, Thomas Kuhn says, scientific revolution, scientific progress is through revolution, it is not a gradual process, it is not a linear process, it is not accumulation, but a revolution sudden change. How does the sudden change come about? He has certain

ideas, he says mostly it is the flush of a genius, a genius person comes up with a new theory, new paradigm overnight, mostly it is through so intuitive genius of certain persons that a new paradigm take shape.

Once the new paradigm takes shape, it implies that the old paradigm is completely discredited, because scientists now, see things in a completely different way. There is no compatibility between the old and the new paradigm and here we come to the next argument of Thomas Kuhn, where he says that the new as well as the old paradigms are incommensurable.

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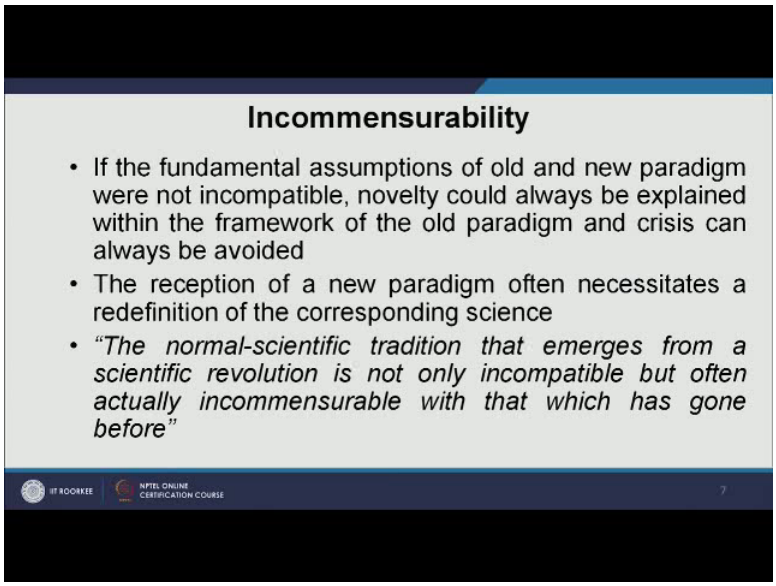


He says, if the fundamental assumptions of old and new paradigm were not incompatible, novelty could always be explained within the framework of the old paradigm and crisis can always be avoided, a crisis situation comes when there are series of anomalies, which challenge the existing paradigm, such crises can always be avoided, if novelty can always be explained, newness, new ideas that has come about, new things that has some scientists have come up with, can always be explained within the existing paradigm. If the fundamental assumptions of existing paradigm can explain the new things, the novel things, then there would not be any need for paradigm shift.

Hence, he argues that old and the new paradigms are incommensurable, incompatible. The reception of the new paradigm often requires a redefinition of the corresponding science redefinition. You have to redefine the way, you have been looking at the world, you have to redefine your method, you have to redefine your instrumentation, you have to redefine your theories, because in a new paradigm things are looked at in a completely different way. Hence, the new and old paradigms are not commensurable, the normal scientific tradition that emerges from a scientific revolution is not only incompatible, but often actually incommensurable with what; which has gone before.

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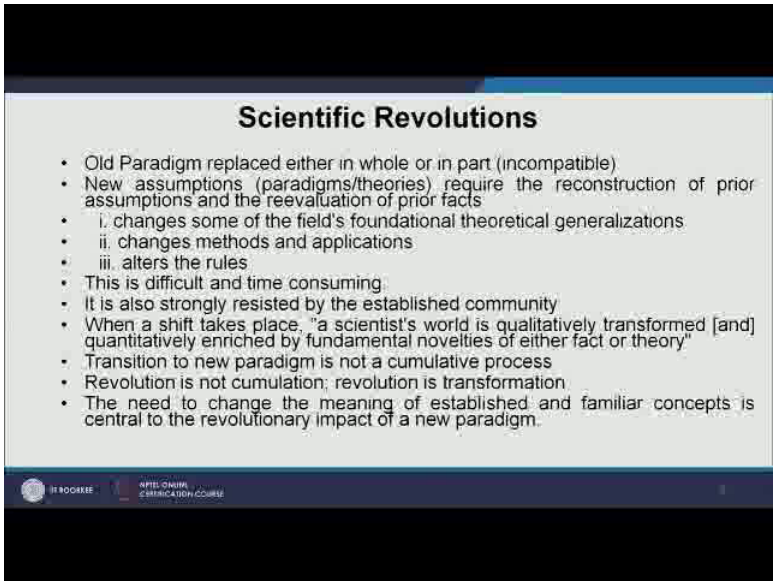


Now, new assumptions of the paradigm that is a new paradigm, it require the reconstruction of prior assumptions and reevaluation of the prior facts, why does it require reevaluation of prior assumptions and revaluation of pair facts? As because it changes some of the fields, foundational theoretical generalization, we can straight away give the example of paradigm, shift from Newtonian mechanics to Einsteinian general relativity, within Einstein's general relativity many of the Newton's argument about motion and matter, about this natural world.

The arguments could not hold, because the new paradigm of Einstein is changed the fields to basic theoretical generalization. It changed it is methods and applications, it is changed and altered the rules. Now, when a new paradigm emerges, it is always resisted by the

established community. When a shift takes place, it is like a scientific.

Scientist world is qualitatively transformed and quantitatively enriched by fundamental novelties of either fact or theory, we have already discussed, then when there is fundamental novelty of fact and theory newness. In fact, in theory only then it provides the basis for a paradigm shift and we have already made this point that, Thomas Kuhn argues scientific progress does not happen in a linear fashion, it is not a linear process scientific advance, scientific progress is not cumulation.

It is transformation, it is revolution, it is sudden dramatic rather continuous gradual linear and that is one of the novelties of Thomas Kuhn, when he describes the scientific developments in the history of science. So, we have already discussed about this point of incommensurability, when we come to invisibility of revolution.

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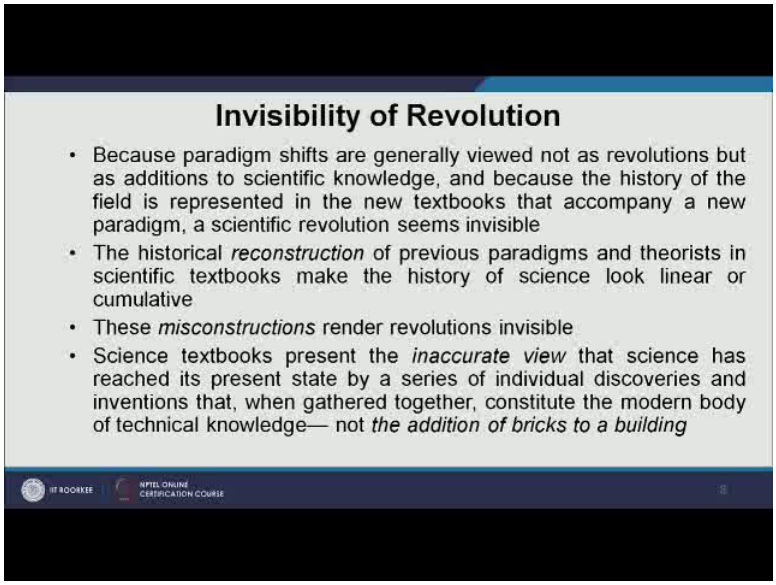


He says, when scientific textbooks in any field are written, the written in such a way that the old as well as the new paradigms are discussed and kept in the same book; thereby, giving the readers a feeling that scientific progress is linear gradual. Hence, the scientific revolutions become invisible, because the way the textbooks in science are written, how does it? How is it written? The textbooks are written, where both old as well as the new

paradigms are discussed and kept in the same book. So, that gives us a feeling as if the scientific paradigms send science progresses in a linear fashion. One theory modified, further added upon by another theory, it is cumulative, when he says no, it is not cumulative.

It is transformative, it is revolution, but this revolution becomes invisible, because the science textbooks present inaccurate view, that science has reached its present state by series of individual discoveries and inventions that, when gathered together, it constitute the modern body of technical knowledge, but that is not how Thomas Kuhn views the progression.

In science he says, progression in science is not addition of bricks to a building; it is not like one brick represents one new theory, which is added to the L wall, then another brick, which is another theory, another concept. Another new theory which is added to the further, added to that wall, it is not; so scientific advance is not the addition of bricks to a building, it is construction building of separate building all together. This is scientific revolution, which has nothing in common with the previous scientific paradigm, because they are income incommensurable, they are incompatible. They do not have anything common in terms of theory concepts method instrumentation.

Hence, I will just sum up this point, regarding invisibility that the historical reconstruction of previous paradigms and theorists in scientific textbooks make the history of science. Look linear or cumulative, it makes a revolution invisible. It disappears, because the way it is mentioned in books, it appears as if one comes after the another and there is some linkage, there is some connection, it has evolved one theory, has evolved from the previous theory, which is not the case, then we come to the final part of scientific revolutions and paradigm shifts, that is how does he explain scientific revolutions. He explains through giving analogy from psychology, he brings some, a concept called gestalt shift, what is a gestalt shift.

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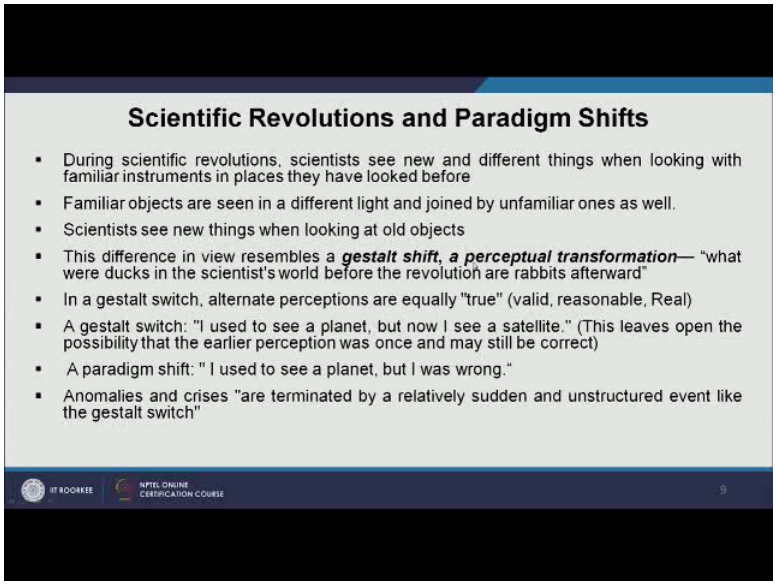


It is a perceptual transformation, what were ducks in the scientist world before the revolutions are rabbits; afterwards this is a perceptual transformation. Now, I will show you a picture.

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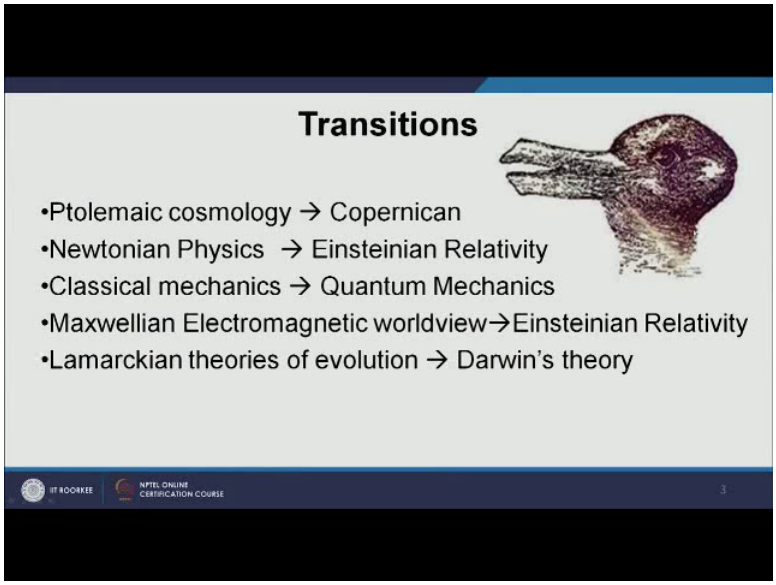


Now, look at this picture, what do you see? Here, if you look at the picture, you see a

duck, only a duck. If you closely look at the picture, you will also see a rabbit, but you will not see a rabbit and duck together, either you will see rabbit or you will see duck, it is gestalt shift. It is perceptual transformation, this he links to scientific revolutions.

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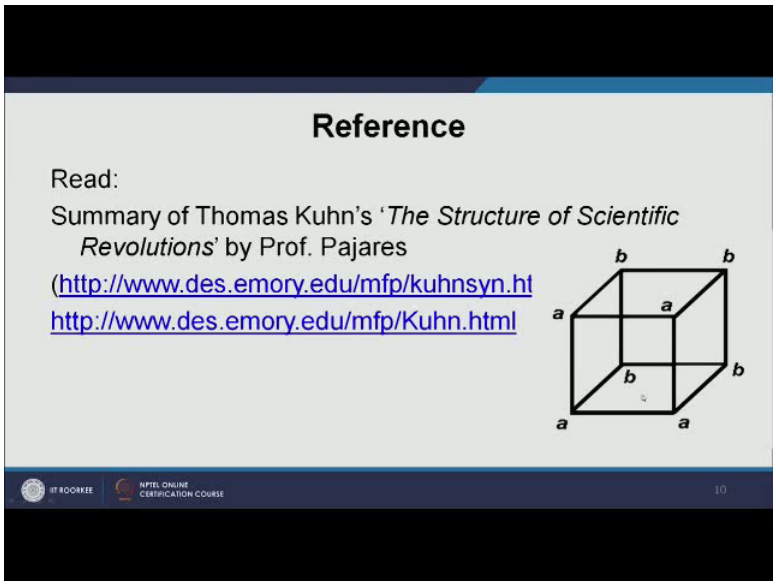


Now, let us look at another diagram, look at this. In this cube either, you see all a's or you will see all b's, this three dimensional figure. We will only see a's or b's not together right again.

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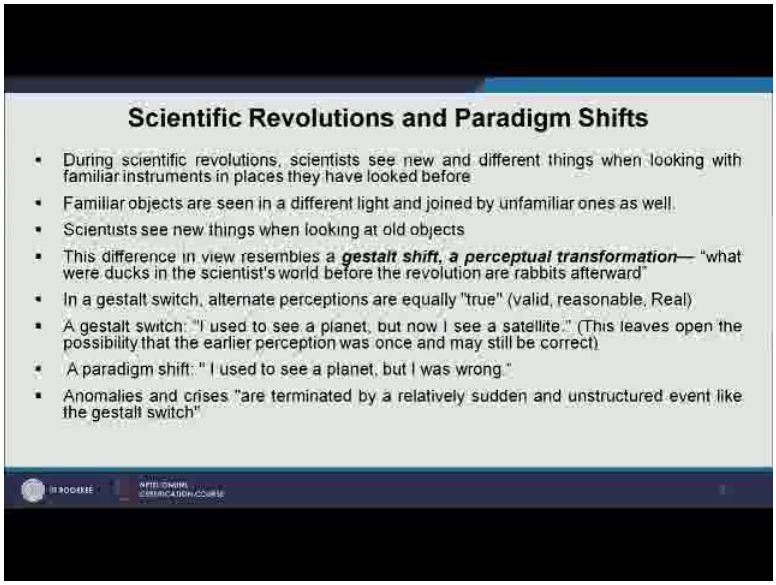


This is an example of a gestalt switch, gestalt shift perceptual transformation, but it says this fine. We can compare gestalt shift to a scientific revolution, but up to this point, but there is a difference, what is the difference between gestalt shift and scientific revolution in gestalt switch? Alternate perceptions are equally true, if you see duck is fine, if you see rabbit. It is also fine. Now, valid the reasonable, they are real in a gestalt switch, if you look at a planet will put it this way. I used to see a planet, but now, I see a satellite, this leaves, open the possibility that the earlier perception was once or may still be correct all your, I used to see a planet.

But; now, I see a satellite like for instance; the case of Pluto, Pluto was considered as a satellite earlier, but now, it is considered as a Planetolio. Now, it is considered as a satellite. This allows us to accept that both the versions can be true, but in a paradigm shift, it will be like this. I used to see a planet, but I was wrong. Why? Because it is incommensurable, it is incompatible anomalies in crisis are terminated by relatively sudden unstructured event, like the gestalt switch in scientific revolution. Familiar objects are seen in a different light and joined by unfamiliar ones. Scientists see new things, when they look at the old object, they look at the same object, but I look at it, in a very different way. Hence, it is a scientific revolution. Hence, the old and the new paradigm do not commensurate, are not compatible and the point that if it is a revolution, why does not it appear like a revolution? It is, because the way the science textbooks are written, where

old and new paradigms are discussed in the same book back to back, it gives the reader a feeling that there is a continuity though the old, new paradigms are a modification on the old ones.

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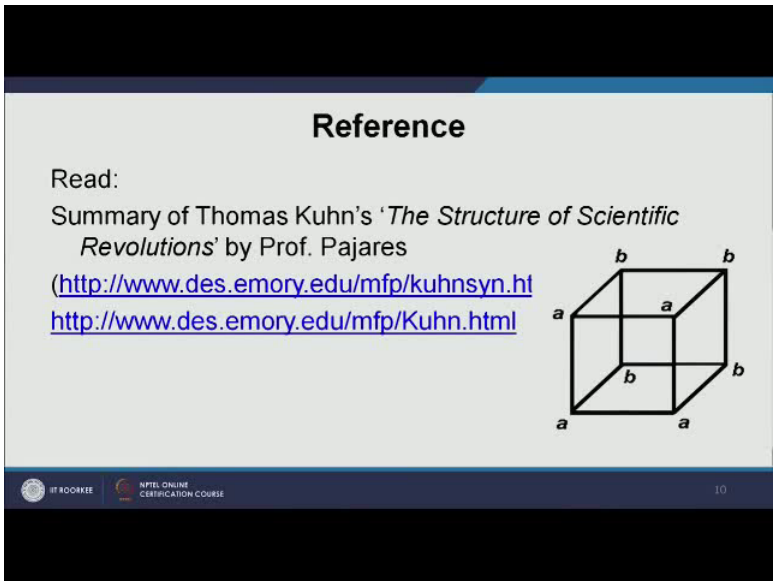


So, now we wind up our discussion on structure of scientific revolutions. This is a reference, an unlined reference, which I have given, which you can always refer to, but reading the original is always better. Scientific revolution thesis of Thomas Kuhn has also met with lot of criticism along with acceptance, along with visibility and readability of the book., it has also met with some criticism from philosophers of science like Lakatos (Refer Time: 33:12) Stephen Stallman Tolman from Karl popper, the people who said that scientific revolutions are not as dramatic as it is described by and it is not as certain, as it is described by Thomas Kuhn, they are always new things coming within a scientific paradigm, you do not have.

There is no need for a change in paradigm to have a complete new scientific revolution; say, scientific revolutions in terms of newness is always appearing emerging within a scientific paradigm, then there are arguments which looks at like for instance, sociologists say that, we cannot claim that we have a single paradigm or dominant scientific paradigm, because sociology is considered as a multi paradigm perspective.

There is prevalence coexistence of multiple paradigms like structural functionalism, like conflict theory, like interactionist theory, like post modernism, all these things coexist. So, sociologists would say that, it cannot, the arguments cannot be applicable to sociology, at the same time that other sociologists who say that we need to have a homogenized theoretical structure. We need to have a single paradigm, single theoretical explanation for the social world. Now, in the next lecture, I shall discuss Karl Poppers Theory of Falsification, which is a (Refer Time: 35:09) in methodology of science and in that concluding part, I will also discuss briefly the argument between Popper and Kuhn.

Thank you.