Sociology of Science
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Lecture – 12
Structure of Scientific Revolutions: Thomas Kuhn - Part I

Dear students, today we will discuss Thomas Kuhn's structure of scientific revolutions. This is it ties in the history of science till last lecture we have been doing sociology of science. When we discussed Robert Morton's Matthew effect in science the symbolism of intellectual property Matthew effect too when he talked about accumulated advantages and disadvantages for initial trend capacity that was sociology of science, we looked at a social nature of science.

Now, what Thomas Kuhn has done? He has come up with a book which revolution and I revolutionized the way science was visualized till then. In 1962 he published the structure of scientific revolutions this was published by University of Chicago press and this completely changed the way science was looked at till then it is one of the most significant books of 20th century in nonfiction category.

Who is Thomas Kuhn? Thomas Kuhn was a physics graduate and a PhD in physics from Harvard University. He took his BS, MS and PhD from Harvard University in 1940s. In 1949 he joined the Harvard University as a lecturer of History of Science. Why did he choose History of Science though he was a PhD in physics? He says in his undergraduate days at Harvard University he got an opportunity to teach the non science students over the history of science that is when he got interested in the history of science, in the classical scientific treatises the classical works of let say Aristotle, Ptolemy, Galileo he found something very interesting about those works. He says that when he read Aristotle he found that though he was claimed to be a genius, a bright mind, but his conceptualization that is Aristotle conceptualization of motion was rudimentary, it was at fault with a modern scientific tradition on motion. So, it did not agree with the Newtonian formulation of motion.

So, according to Thomas Kuhn it was not bad Newton, Aristotle was not bad Newton it was different and depending upon the context, depending upon the time period when

Aristotle was writing was conceptualizing his ideas it was perfectly acceptable. And that is when he got this idea of paradigm and paradigm shift. Further I shall give another example he says, Thomas Kuhn says that when Ptolemy argued that the earth is at the center of the universe, not sun he presented certain cycles and epicycles what are cycles and epicycles they are the geometrical models regarding the planetary positions and calculations that are involved with it. So, with those calculations he could convince the scientific community of his time that earth is at the center of the cosmos. Now, when Copernicus wanted to prove otherwise when he argued that it is not earth, but sun is the center of the solar system of the cosmos he made a mistake he made use of the same cycles and epicycles, the same geometric models, the toolbox that was provided by Ptolemy.

So, his calculations could not be accurate. Hence the scientific community discredited his argument discredited his thesis that sun is at the center of the universe. Thomas Kuhn says that the scientific community was justified in doing so, because Copernicus who could not provide conclusive evidence in support of his theory hence he was rejected. Thomas Kuhn says that is accepted because in those times people looked at facts and he did not have the correct facts.

Then another example I would like to give here is that from chemistry in 18th century which again has been discussed by Thomas Kuhn in 18th century chemistry the homogeneous solution of water and alcohol was considered as a compound, because water and alcohol could be mixed in any proportion and it could not be separated sp spontaneously it would not suffer separate spontaneously, and complete separation was also not possible upon distillation. Hence it was considered as a compound where it could be mixed in any proportion. Now, that was accepted depending upon the timeframe in which this proposition was made in the 18th century scientific world of chemistry.

But in Dalton's atomic theory it negative that. Dalton's atomic theory said that atom can be combined only in whole number ratio in fixed ratio. So, when we say alcohol and water can be combined in any proportion that is wrong. Now, we this is a conventional theory. But then water in with the combination of water and alcohol being considered as a compound was acceptable because of the data said that was available at that time which proved that it is so. Hence what Thomas Kuhn is arguing is that every in every timeframe

in every historical period in science there is a body of thought which is the dominant body of thought and everything all the scientific activity subscribed to work within that framework, within that body of thought. Now, with this basic bag background I come to the basic model of Thomas Kuhn regarding structure of scientific revolution.

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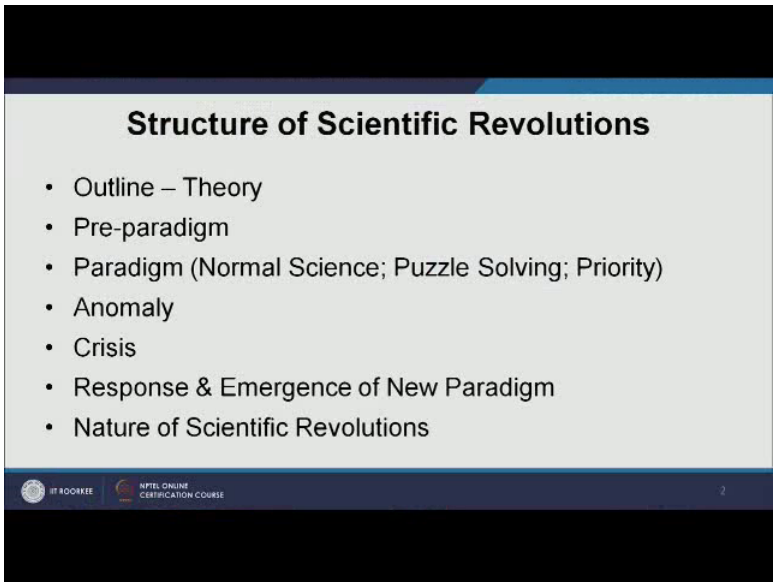

This is how the outline of the lecture is, first will discuss what is pre-paradigm then will discuss the paradigm that is the period of normal science which is also the period of puzzle solving activity. Now, we will come to the anomalies the crisis in scientific world, followed by the response to crisis and emergence of a new paradigm and the nature of the scientific revolution.

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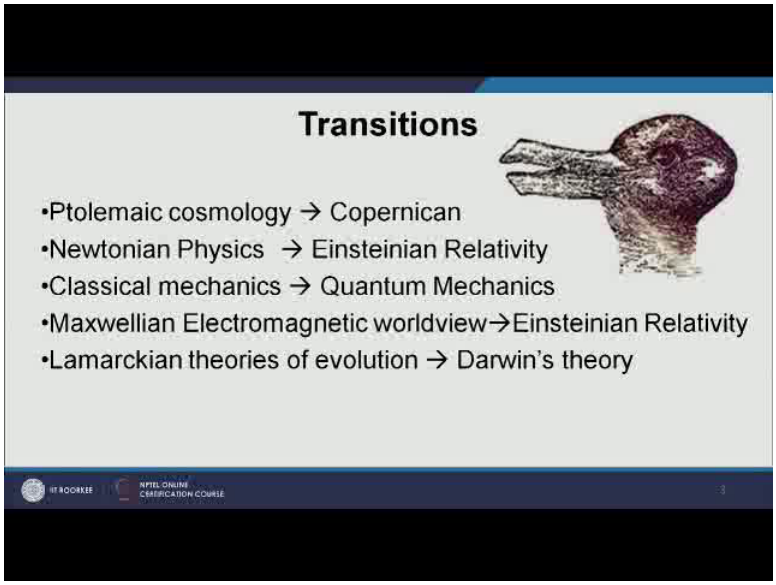

Now, let us look at some of the transitions of paradigm shifts in scientific world in different fields and subfields Ptolemaic cosmology to Copernican model Newtonian physics to Einsteinian relativity, Classical mechanics to quantum mechanics, Maxwell in electromagnetic worldview to Einsteinian relativity, Lamarckian theory of evolution to Darwin's theory of evolution these are the paradigm shifts in different fields in different subject domains.

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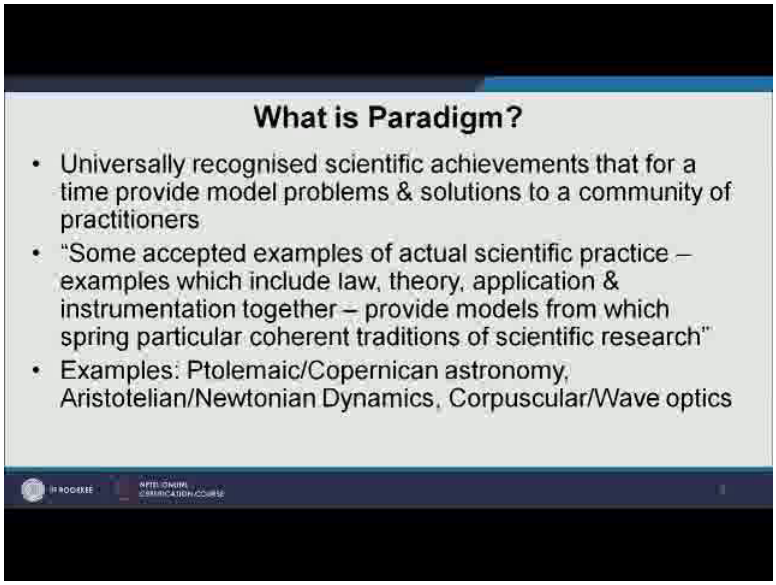

Now, what is paradigm? This is a, this word paradigm has become part of our day to day vocabulary, it is in fact, used very loosely, but original coin is of the term included a certain content and that content is what I am going to discuss here. This is the definition of paradigm by Thomas Kuhn. For him paradigm is universally recognized scientific achievements that for a time provide model, problems and solutions to a community of practitioners.

So, a scientific achievement which is universally recognized that is it is accepted by the scientific community let us say a paradigm in chemistry. So, this paradigm which has been arrived at by one scientist or a group of scientists, it has to be universally accepted and recognized and once that is universally accepted it provides the model problems and solutions to the community of practitioners to the community of scientists working in the field of chemistry for instance in this case. They provide a model problems and solutions for the scientists to work on for that particular period of time till a new paradigm is established.

Now, another way of looking at paradigm is it is some accepted examples of actual scientific practice which includes law, theory, application and instrumentation and they provide models from which spring coherent tradition of some scientific research. So, scientific paradigm a paradigm includes law, theory, application and instrumentation. So, method, instruments, law and theory all these things are part of the paradigm and that helps the community of practitioners to do their day to day research, a routine research which is the period of normal science.

Now, exam again examples of such paradigms are ptolemaic model to Copernican astronomy, Aristotelian model to Newtonian dynamics, Corpuscular to wave optics, they are examples of paradigms.

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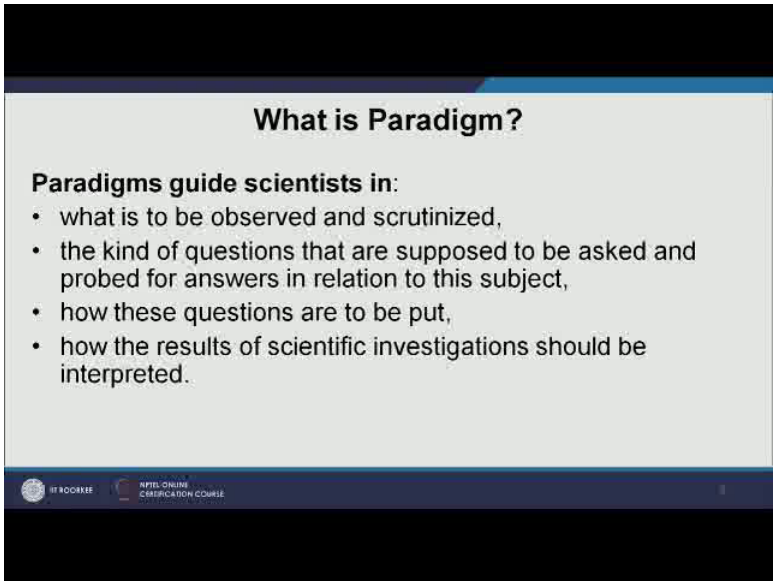

Now, how does paradigm guide the scientists? It guides the scientist in what is to be observed and scrutinized. The kind of questions that are to be supposed to be asked and proved for answers in relation to the subjects, how these questions are to be put, how the results of scientific investigation should be interpreted. So, this paradigm helps the scientists in determining the scientific problem, how to go about researching that scientific problem, how to collect data, how to do experiment, what method to use, what instrumentation to use, what questions to be asked all these things are guided by the scientific paradigm within which the scientist operate.

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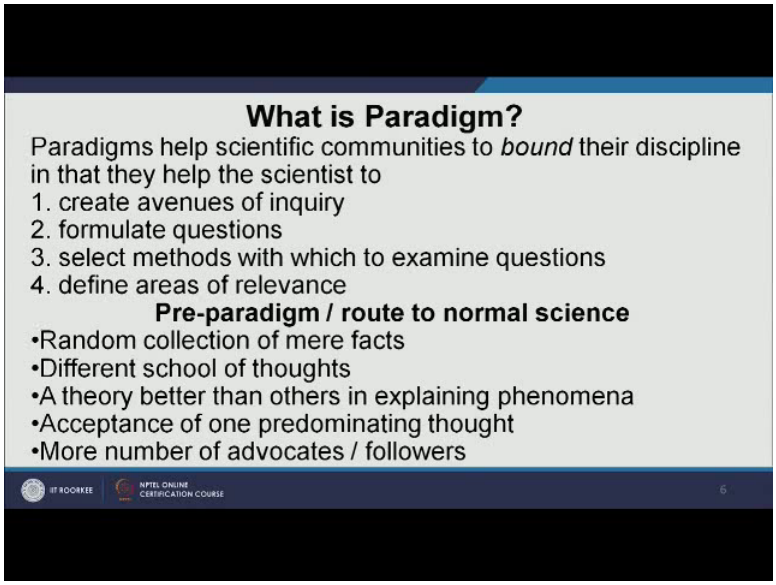

It helps, the other paradigm helps the scientific communities to bound their discipline in that the hell the scientists to create avenues for inquiry. It helps the scientists to formulate new questions, but this new questions has to be within the purview of the paradigm. The select methods with which to examine questions and define area of relevance that is the paradigm help the scientist to demarcate the subject matter, and within this demarcated subject matter they look for new problems, look for solutions to these problems. They are guided by the paradigm to use certain methods certain instruments, certain techniques of data collection of laboratory experiments it helps them to answer questions that has been formulated in the beginning within that paradigm.

Now, we will talk about pre-paradigm or pre-paradigmatic stage which is the route to normal science the pre-paradigm states is states where the multiple paradigms who are competing for acceptance and dominance the different schools of thoughts, all the schools of thoughts are competing for acceptance by the greater scientific community by the wider scientific community, a theory which is better than the others in explaining the phenomenon or the natural or social is slowly gets accepted.

This one theory or one paradigm which gets accepted as the dominant theoretical model becomes the next paradigm. As it gets accepted initially by a few scientist slowly others also join in other scientists also start believing in that scientific paradigm and it becomes

accepted dominant scientific paradigm. So, in the pre pre-paradigmatic stays there are multiple theories which are competing for acceptance then one of them which who is good at better at explaining the phenomenon natural or social phenomenon gets slowly accepted by a few scientist then slowly it gets accepted by a few scientist then slowly it gets accepted by the wider scientific community till it becomes a predominant scientific paradigm, then we come to the period of normal science.

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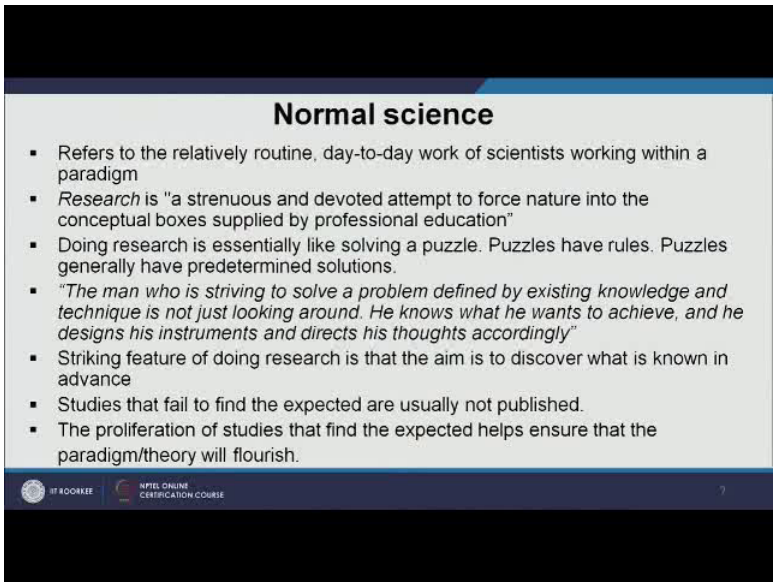

For Thomas Kuhn normal science is done within a paradigm. Once a paradigm becomes a dominant paradigm and a community of practitioners a scientific community one accepts it as the dominant scientific paradigm then begins the period of normal science which essentially refers to relatively routine day today work of scientists, working within a paradigm is a routine work of scientists who work within the paradigm. And in normal science is in a very interesting way he defines it as within normal science research is a strenuous and devoted attempt to force nature into the conceptual boxes supplied by professional education.

What does it mean? It means that you have a paradigm which has provided a set of theories and concepts, when you do research within the paradigm we are trying to force your results what type of observations you have come up with, whatever findings we have come up with, whatever results you have come up with it has to be interpreted within that

dominant paradigm. So, we are essentially what we are doing we are forcing these observations this findings this results into those conceptual boxes that are available to you to make it work, to make it acceptable by the wider scientific community, because the wider scientific community is in agreement regarding the credibility of the dominant scientific paradigm.

So, if you are doing research within that dominant scientific paradigm then the your results must tally with the conceptual boxes provided by the paradigm, and for him doing research is essentially like solving a puzzle a puzzle puzzles of rules puzzles have predetermined solutions. So, when you do research during the period of normal science within a dominant scientific paradigm it is like solving puzzles because when you solve a puzzle every puzzle has predetermined end you must find a way to reach there, hence the man who is striving to solve a problem defined by existing knowledge and technique, it not just looking around he knows what he wants to achieve and he designs his instruments and directs his thoughts accordingly. Now, this quotation that I am quoting here it says the scientist is a man, a male that is because the writing in 1962 when this book was published till then the academic writings were not gender neutral. Now, we write instead of he will write they or he or she. So, when I quote a statement where it talks about scientists being male scientist and he knows what he wants to achieve he designs his instruments this actually means scientist male or female he or she alright.

So, let us go back to this statement once again to solve the puzzle provided by Thomas Kuhn. He says when we do research we actually try to solve a puzzle why because we are working with an existing paradigm where we know exactly what to find because puzzles have predetermined ends. Man who is striving to solve a problem defined by existing knowledge is not looking around he knows what he wants to achieve and he designs his instruments and directs his thoughts accordingly.

So, the striking feature of doing research within normal science is that the aim is to discover what is known in advance. So, studies that find the expected are accepted, studies that failed to find expected are usually not published the proliferation of studies that find the expected, it helps, ensure that a paradigm or theory will flourish how does the paradigm flourish, how does the paradigm continue to remain the dominant paradigm continue to influence a scientist only when there is proliferation of there is tremendous

amount of research being undertaken within normal science which proves for the proofs a test for the artists the dominant scientific paradigm. And that can happen when you find the expected, when you design your problem, when you formulate your question you already have a answer in your mind predetermined answer in your mind and study that failed to find the expected are usually not published.

So, the normal science it does not necessarily explains all unexplained because it is working within a paradigm where you cannot go beyond a paradigm you cannot go beyond the theoretical knowledge provided by the paradigm because if you go beyond that then it will not be accepted for publication or in the form of article or in the form of a book or cannot be accepted in any academic seminars or conferences. Essentially the scientific community is they agree upon the fundamentals and they also agree upon what is to be observed and scrutinized. It provides the kind of answers that are supposed to be found by asking certain questions. How these questions are to be dealt? How these questions are to be asked? How to look for answer? All these things are provided by guided by the scientific paradigm which is the dominant one, whether it is in chemistry or in physics or in geology or in biology any scientific field.

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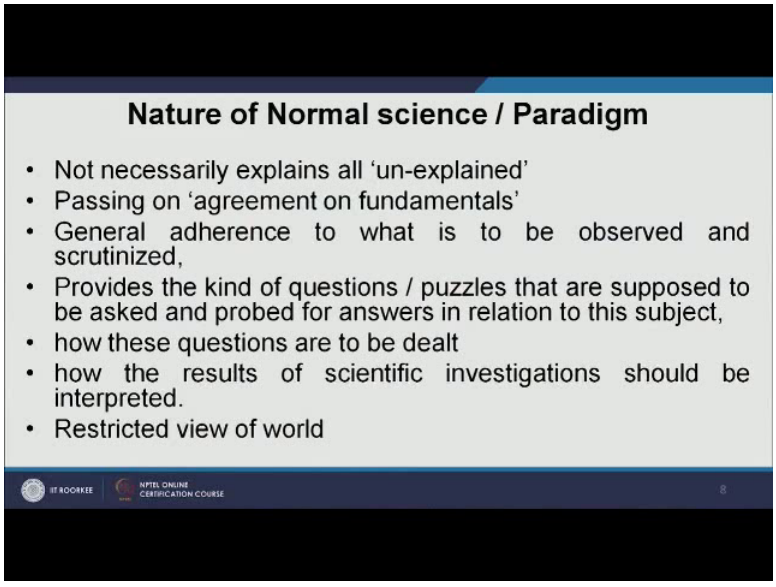

So, as it appears the way Thomas Kuhn argues normal science has a restricted view of the world because everything has to work within that paradigm if you do not adhere to the to

the arguments of the paradigm then it will not be accepted your work will not be accepted.

Now, there are certain examples which has been given by Thomas Kuhn in different fields which constitute the paradigms in the different fields. I will just write it down in the blackboard.

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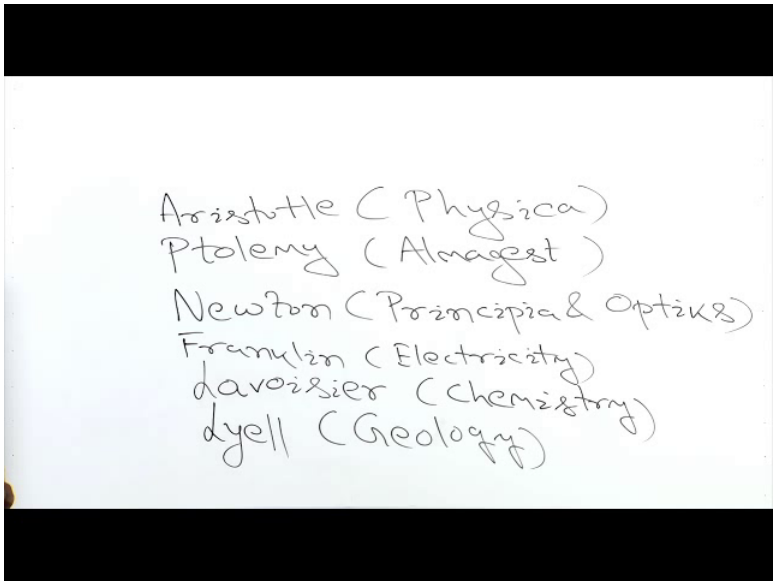

Now, these are the seminal works paradigm shifting works in different fields in chemistry, in physics, in electricity, in the field of electrical sciences in chemistry in geology. Aristotle's Physica his book on Physica changed the way people looked at physics and motion and matter during his era. Ptolemy's Almagest it changed the way astronomy was perceived till then. Newton's Principia and Optics we all know change the modern science considerably. So, it constituted this book through this book they brought about through these books they brought about paradigm change, paradigm shift. Franklin's Electricity laborious book on chemistry or lyell's book on Geology.

All these things were path breaking works, groundbreaking research which was published in this books and this books were the carriers of scientific paradigm, new scientific paradigm. It helped define the problems legitimate problems and methods of research for

a succeeding generation of scientists and scientific practitioners.

So, how these books are important? According to Thomas Kuhn this classics and textbooks. Now, the textbooks can be both elementary as well as advanced, it further solidifies normal science due to two factors.

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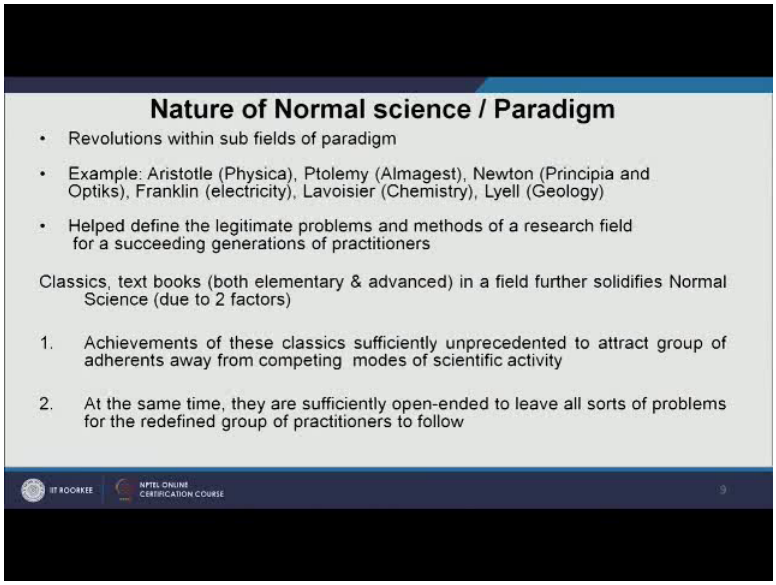

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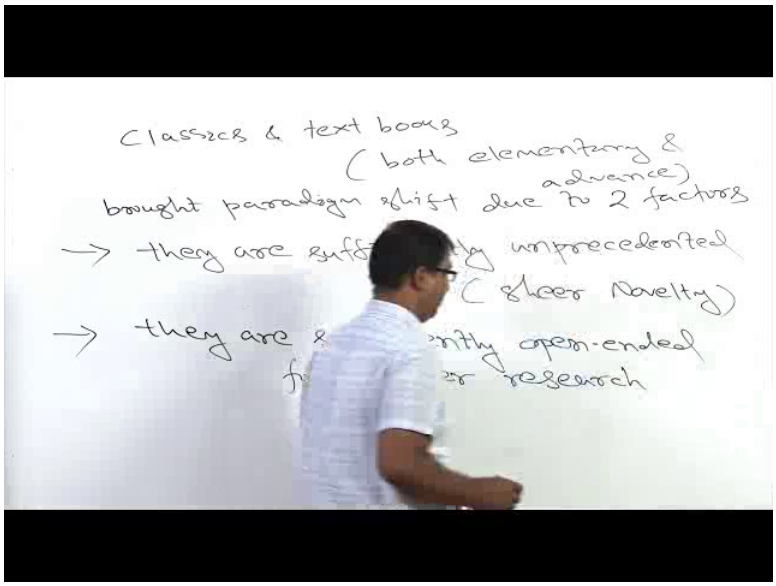

Just note it down in the blackboard. So, if you look at the blackboard first I mentioned the classic works in different fields like Aristotle's Physica, Ptolemy's Almagest, Lavoisier book on chemistry all these books are groundbreaking path breaking work. This classics or textbooks which are can be both elementary and advanced it can further solidify normal science due to two factors.

First achievement of these classics sufficiently unprecedented to attract a group of adherents away from competing modes of scientific activity, that is it says that this books are sufficient has certain novelty sheer novelty which attracts the scientific practitioners towards this book, towards argument made in this book hence towards the paradigm that has been proposed by the author. Second this books are also sufficiently open ended. So, as to provide scope for the successive scientist to look for new problems and new solutions based on this problems and which helps in the activities of normal science in the continuing day to day research of the national science.

So, till now, I discussed what is paradigm, what is pre-paradigm, how pre-paradigm stays moves to paradigm stays and the paradigm stays is known as period of normal science where puzzle solving act science is nothing, research is nothing, but puzzle solving activity. In the next lecture I will talk about the paradigm shift scientific revolution and the incommensurability and invisibility of scientific revolutions.

Thank you.