

Philosophical Foundations of Social Research
Professor Sambit Mallick
Department of Humanities and Social Sciences
Indian Institute of Technology, Guwahati
Week 6 : Lecture – 16
The Structure of Scientific Revolutions

Hello, everyone. Welcome to the 16th lecture of this massive open online course on Philosophical Foundations of Social Research.

Course outline

Week 5 (Three Lectures)	Week 6 (Four Lectures)
Karl Marx <ul style="list-style-type: none">• Idealism versus materialism• Materialist conception of history• Principles of dialectic• Understanding nature• Ideology and science: methodological implications	Karl Popper <ul style="list-style-type: none">• Principle of falsification• Context of discovery and justification• Hypothetico-deductive model Thomas Kuhn <ul style="list-style-type: none">• Consensus-driven paradigm• Normal science• Anomalies• Crisis• Revolutionary science• A new paradigm

If you slightly recall, we are in the sixth week of this course - this is the sixth week has been designed in such a manner so that we can cover Karl Popper and Thomas Kuhn. We have already discussed Karl Popper, today, and in the 17th lecture, we are going to cover Thomas Kuhn. Very quickly if we have to recapitulate whatever we have discussed in Karl Raimund Popper, we have discussed how Popper systematically attacked the positivistic construal of science.

Karl Raimund Popper

- Attack on positivism
- Nature of science
- Central question of philosophy: the problem of cosmology

Central question of philosophy

The problem of cosmology

The problem of understanding the world including ourselves and our knowledge of the world as part of the world

And he not only systematically attacked the positivistic construal of science, but also provided an alternative image of science and thereby he tried to work on the nature of science itself. And by working on the nature of science itself, Popper started with the central question of philosophy.

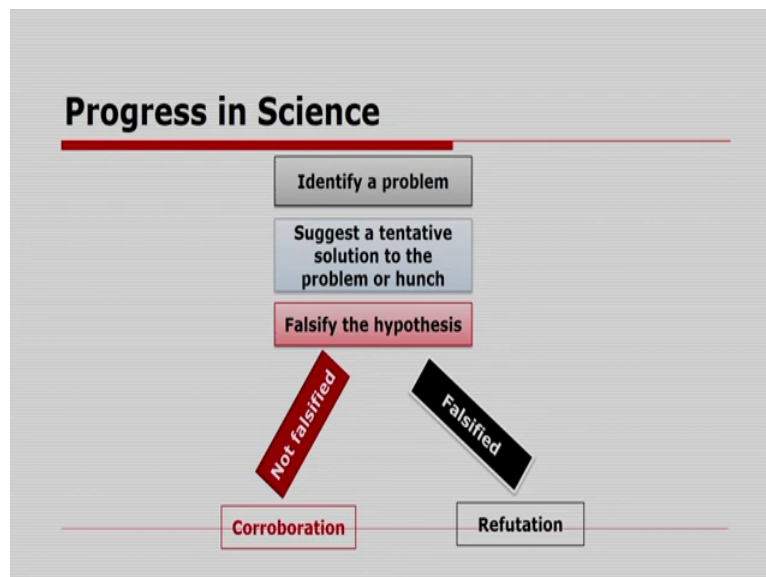
What is the central question of philosophy? According to Popper, the central question of philosophy is the problem of cosmology. What is the problem of cosmology then? According to Popper, the problem of cosmology is the problem of understanding the world, including ourselves and our knowledge of the world as part of the world.

-
- Context of justification and context of discovery
 - Demarcation between science and non-science
 - Systematic falsification
 - Hypothetico-Deductive (H-D) model
-

Then, according to Popper, philosophy of science must confine itself to the context of justification. And Popper refuses to say anything about the context of discovery, because of a rationalist account of science was associated with, according to Popper, context of

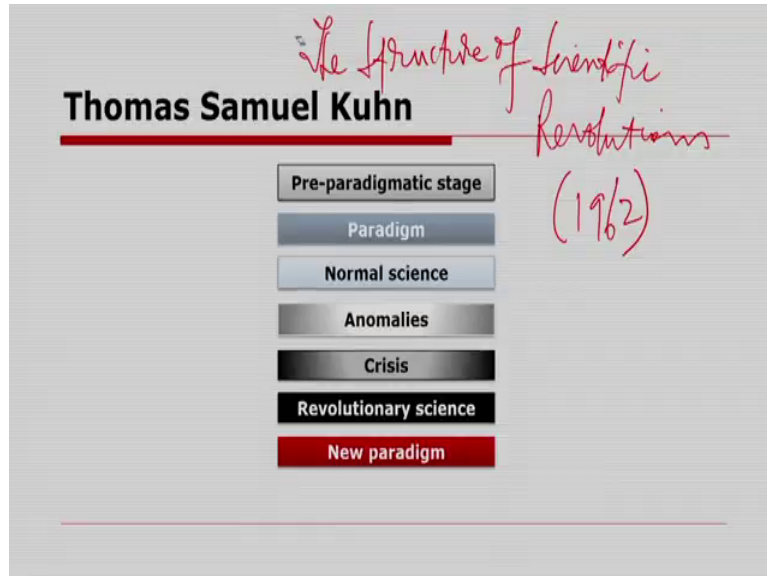
justification, not context of discovery. He also like positivists and empiricists and rationalists. tried to seek a demarcation between science and non-science. Unlike positivists who suggested that the hallmark of science lies in the fact that all scientific statements must be systematically verifiable. Popper suggested that, the hallmark of science lies in the fact that all scientific statements must be systematically falsifiable. And that is how he came to the point of hypothetico-deductive model.

In the case of empiricism, the method of science is the method of induction, in the case of rationalism, the method of science is the method of hypothesis. In the case of positivism, the method of science is the method of induction again, for Popper the method of science is the method of hypothetico-deduction.



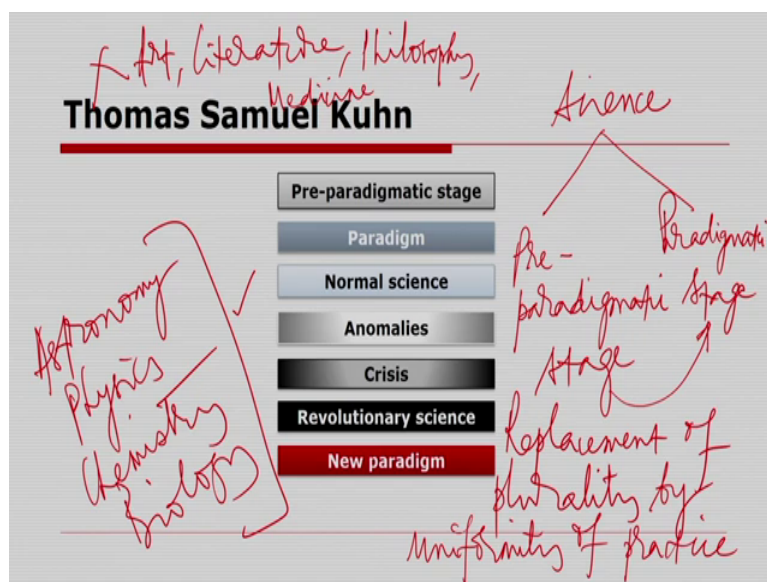
And this is how science has made progress, according to Popper, , one must identify your problem, then suggest a tentative solution to a problem or hunch. That is hypothesis, then we tend to have falsify hypothesis, if the hypothesis is falsified, then it must be refuted, and if the hypothesis is not falsified, then it must be corroborated, the hypothesis must be kept permanently tentative, that is how Popper tried to look at this.

And what we have discussed in the last class that Kuhn and Feyerabend have convincingly argued that a shift from one theory to another is accompanied by a shift in the meaning of the works that are common to both the theories, old and new theories.



If so, Poppers characterization of growth of science is continuous then collapses, I think we stopped here then we are going to discuss Thomas Samuel Kuhn. In terms of two lectures, we are going to not only discuss Kuhn, but also a comparison between Popper and Kuhn that is very important.

We now briefly look at the views of Thomas Samuel Kuhn, who his magnum opus, "The structure of scientific revolutions" was published in 1962 that constitutes a turning point in the 20th century philosophy of science. Before we move on to the radical ramifications of Kuhn's views, let us provide a brief exposition of Kuhn's fundamental ideas.



For Kuhn, each or every major science passes through two stages; one is pre-paradigmatic stage and the other paradigmatic stage. During the pre-paradigmatic stage, one finds more

than one mode of practicing that science. Let us see how, during the pre-paradigmatic period or stage of a science, one finds more than one mode of practicing that science.

Thus, there was a time when there were different schools in astronomy, which practiced astronomy differently. So, was the case with the disciplines like physics, chemistry and biology. Their situation at that stage of their development was similar to the one which obtains today in the case of creative areas like art, literature, philosophy, and even medicine, where you will find divergent modes of practice in these disciplines coexist. But, whereas, even today we speak of schools of art, schools of literature, schools of philosophy and systems or schools of medicine, we do not speak of schools of astronomy.

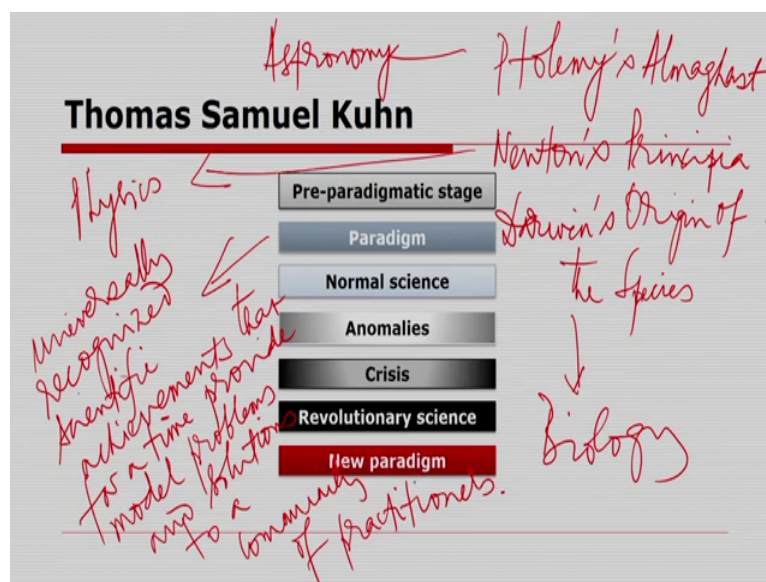
You may find schools of medicine: you will find there is homeopathy, there is allopathy, there is naturopathy, there is Ayurveda, there is Unani, there are different systems of medicine. If I say, in political field, is there any consensus on the type of governance somebody may say, no presidential form of government is the best, somebody may say, no, parliamentary democratic system is the best, somebody may say no totalitarianism is the best, there is no consensus.

That is why you will find there are different schools of political science. There are different schools of Social Sciences, there are different schools of humanities, there are different schools of art, literature, philosophy, and even medicine. But when you come to astronomy, physics, chemistry, biology, you will not find schools in plurality; you will find that uniformity within the school. That is why, whereas even today, we speak of schools of art, schools of literature, schools of philosophy, and systems or schools of medicine, we do not speak of schools of astronomy, schools of physics, schools of biology and so on. This is because according to Kuhn, areas like art, literature, philosophy, and even medicine did not and perhaps cannot make a transition from pre paradigmatic stage to paradigmatic stage.

But for astronomy, physics, chemistry, biology, they have already made a transition from the pre paradigmatic stage to paradigmatic stage. So, what characterizes science which enters the paradigmatic stage is the disappearance of the plurality of schools. In other words, the transition from pre paradigmatic stage to the paradigmatic stage implies the replacement of plurality by uniformity of practice. Then what characterises a science which enters the paradigmatic stage is the disappearance of schools. There cannot be multiple schools, plurality of schools.

According to Kuhn, when a science reaches the paradigmatic stage, then it becomes mature or science in the present sense of the term. And astronomy was the first discipline to enter the paradigmatic stage followed by physics, chemistry and biology. We will discuss how they entered the paradigmatic stage by replacing the plurality of practices by uniformity of practice. On the contrary, social sciences are very much in the pre paradigmatic stage since they have not yet succeeded in bringing about any consensus over their practice, as is shown by the prevalence of schools in social sciences.

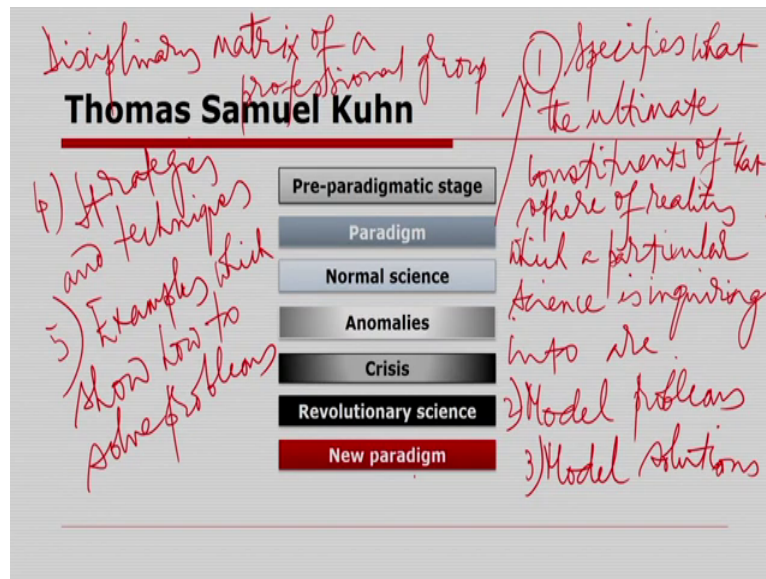
And according to Kuhn, perhaps creative areas like art, and literature, perhaps can never reach the paradigmatic stage. Science thus becomes mature, when it acquires a paradigm. It is the acquisition of a paradigm which replaces plurality by uniformity of practice. Then, the most important question which arises that then what do we mean by paradigms? Paradigm is nothing but a model.



For example, if I have to provide certain examples of paradigm, we all know that Ptolemy's Almagest, Newton's Principia, Darwin's origin of the species are path breaking works in the age of astronomy, physics and biology respectively. According to Kuhn, Ptolemy's Almagest, Newton's Principia and Darwin's origin of the species, these works provided paradigms for these disciplines.

They did so by specifying the exact manner in which these disciplines ought to proceed. They laid the ground rules regarding what problems these disciplines must tackle and how to tackle them. Then what are paradigms? Paradigms are universally recognized scientific

achievements that for a particular period of time provide model problems and model solutions to a community of practitioners, the scientific community.



Then let us see at length and in detail, what a specific paradigm does or what do, what are the functions of a paradigm. First, a paradigm specifies what the ultimate constituents of that sphere of reality which a particular science is inquiring into are. Secondly, a paradigm identifies model problems. Thirdly a paradigm specifies a possible range of model solutions to those model problems.

Fourthly, a paradigm provides the necessary strategies and techniques for solving these problems. It also must provide specific methods to solve the problems, strategies and techniques and methodologies. And finally, a paradigm provides examples which show how to solve problems.

In other words, a paradigm is a disciplinary matrix of a professional group. Then, what are paradigms? Paradigms are universally recognized scientific achievements that for a time provide model problems and model solutions to a community of practitioners.

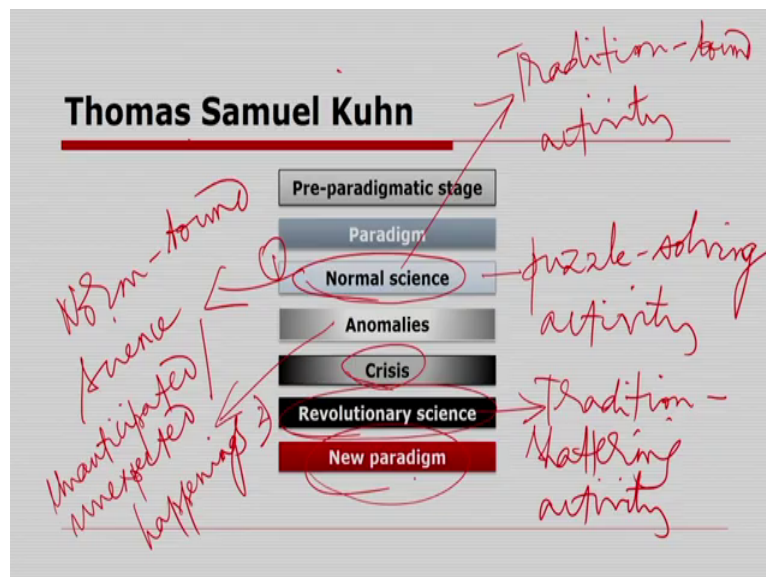
Then first, a paradigm specifies what the ultimate constituents of that sphere of reality which a particular science is inquiring into are. Secondly, a paradigm provides model problems, identifies the model problems. Thirdly, a paradigm specifies the possible range of modern solutions to those modern problems.

Fourthly, a paradigm provides necessary strategies and techniques to solve those model problems. And finally, a paradigm must provide adequate examples, which demonstrate how

to solve these model problems. And thus, a paradigm becomes a disciplinary matrix of a professional group.

Once a science comes to possess a paradigm, it develops what Kuhn calls a normal science tradition. When science becomes mature, that is, when it makes a transition from the pre-paradigmatic stage to paradigmatic stage, or when you will find the replacement of plurality of practices by uniformity of practice, that is how science becomes mature, disappearance of schools and so on that we have just now discussed.

What is normal science for Kuhn? That when he said that one science becomes mature, or when science comes to possess a paradigm model, it develops what Kuhn calls a normal science tradition.



Normal science is a puzzle solving activity for Kuhn: it is the day to day research activity purporting to force nature into conceptual boxes provided by the paradigm. It is a norm bound science. It is the day to day research activity aiming to force nature into conceptual boxes provided by the paradigm.

The practitioner of normal science, norm bound science, that is a scientist which is engaged in day to day research, internalizes the paradigm by professional education. And this explains the prevalence of textbook culture in science education. Of course, scientific practice is not adjusted in terms of day to day research or normal scientific tradition.

When a paradigm fails to promote fruitful, interesting and smooth normal science, then that specific paradigm is considered to be in a crisis. How does science enter into the stage of

crisis? Now precisely because of the anomalies that normal scientific tradition encounters. What are anomalies?

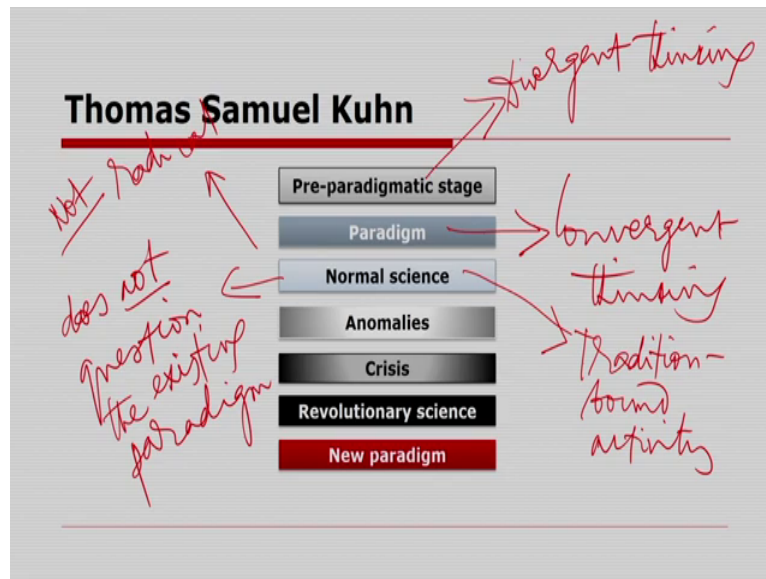
Anomalies are unanticipated or unexpected occurrences or happenings. If you look at these unanticipated or unexpected happenings or occurrences, as a consequence of which normal scientific tradition or norm bound science, it enters the stage of crisis.

The deepening of the crisis leads to the replacement of the existing paradigm by a new one. When existing paradigm must be replaced by a new paradigm this process of replacement is called scientific revolutions, that is how Kuhn's book is titled "The structure of scientific revolutions", then what are what are scientific revolutions or revolutionary science?

If normal science is a tradition bound activity, then for Kuhn, revolutionary science is a tradition shattering activity. Therefore, scientific revolutions are the tradition shattering complements to the tradition bound activity of normal science.

This once science enters the paradigmatic stage, it is characterized by one normal science and two, revolutionary science. In sheer temporal terms, normal science occupies much larger space than does revolutionary science that is to say, science is revolutionary once a while and mostly it is non revolutionary or norm bound for Kuhn. Also the scientific activity engaged by most of the practitioners of science can be characterized aptly in terms of normal science or norm bound science.

Because of this temporal and numerical magnitude, we can say that much of the scientific activity as we ordinarily encounter is normal, though this normal course is occasionally interrupted by revolutions, which change the form, content and direction of the process of the scientific activity, which is basically normal, by which we mean non revolutionary committed and tradition bounded activity. That is why normal science demands thoroughgoing convergent thinking and hence, is preceded by an education that involves a dogmatic initiation in a pre-established tradition that the student is not equipped to evaluate.



That is why you will find that in the pre paradigmatic stage, what we said there were schools of in plurality, schools of thought. In the paradigmatic stage you will find that the plurality of schools of thought disappears and what we generally find that if normal science is a tradition bound activity, then revolutionary science is a tradition shattering activity.

And in the pre paradigmatic stage, you will find there are different schools, there was divergent thinking, but in the paradigmatic stage, you will find convergent thinking because of the disappearance of plurality of schools, disappearance of plurality of practices, you will find uniformity of practice in the context of paradigmatic stage.

Normal science generally does not question the existing paradigm but to increase the precision of the existing theory by attempting to adjust existing theory or existing observation in order to bring the two into closer and closer agreement. And secondly, to extend the existing theory to the areas that it is expected to cover but in which it has never before been tried.

In other words, normal science consists in solving puzzles that are encountered in forcing nature into the conceptual boxes supplied by the reigning paradigm, the ruling paradigm. It is in this way that Kuhn attempts to account for the smooth, defined and directional character of day to day scientific research in terms of the features of what he calls normal science.

Normal science has no room for any radical thinking. Normal science is limited to the enterprise of solving certain puzzles in accordance with the rules, their strategies, the regulations, the techniques specified by the paradigm.

As I said, the paradigm identifies model problems, it provides a range of model solutions to those model problems, paradigm must provide necessary strategies and techniques to solve those model problems. In this sense, what we generally find that normal science is limited to the enterprise of solving certain puzzles. In accordance with these rules, these regulations, these norms, these strategies, techniques, methods, all set of methodology, are specified by the existing paradigm. And these rules are never questioned, but only accepted and followed. The aim of scientific education is to ensure that the paradigm is internalized by a student.

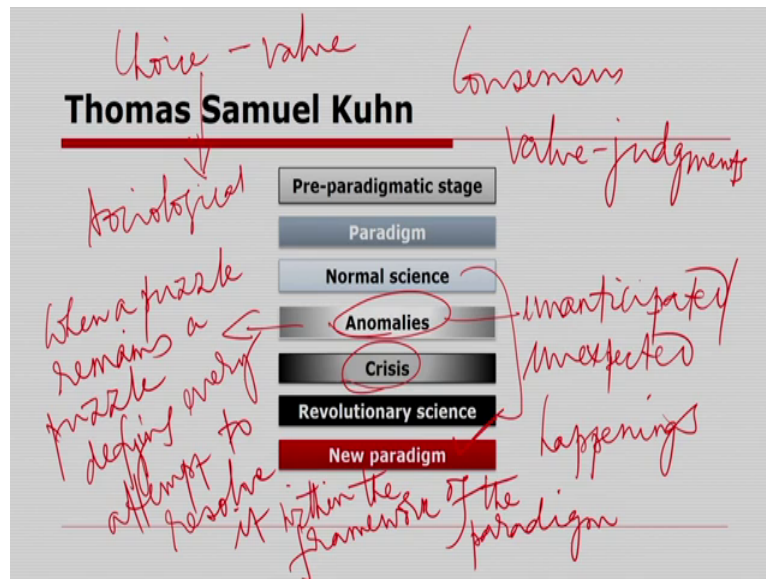
In other words, the professional training in science consists in accepting the paradigm as given and equipping oneself, to promote the cause of the paradigm by giving it greater precision and further elaboration. The day to day scientific research does not aim at anything fundamentally new, but only at the application of what has already been given, namely the theoretical ideas and the practical guidelines for solving certain puzzles. And it is in this sense that normal science is highly a tradition bound activity.

Nevertheless, it is this tradition bound activity, which makes science a successful enterprise. Kuhn suggests that normal science that is a puzzle solving activity is highly accumulative enterprise eminently successful in its aim, objectives, goals, the steady extension of the scope and precision of scientific knowledge.

Then what is the goal of science that we have discussed earlier: the goal of science is the extension of certified knowledge. And in all these respects, normal science fits with greater precision, the most usual image of scientific works, yet one standard product of the scientific enterprise is missing.

Normal science does not aim at novelties of fact or theory, and when successful, finds none. In order to reconcile the undeniable fact of novelty, that science exhibits, by making new discoveries with somewhat hackneyed phenomenon of normal science, it is necessary to show that research under a paradigm must be a particularly effective way of inducing paradigm change, but then how?

As we have discussed earlier, that normal science purports to force nature into the conceptual boxes provided by the ruling paradigm by solving puzzles in accordance with the guidelines provided by the paradigm which validity is accepted without question. During this process of puzzle solving, certain hurdles may be encountered- we then speak of anomalies.



That is an anomaly arises when a puzzle defies every attempt to resolve it within the framework of the paradigm. Anomalies are unanticipated or unexpected occurrences or happenings- anomalies arise when puzzle remains a puzzle defying every attempt to resolve it within the framework of the paradigm. Then, you are not able to solve the puzzles. When you are not able to solve the puzzles, then you tend to encounter anomalies. But appearance of one or two anomalies is not sufficient to overthrow a paradigm.

The ushering in often of the era of a new paradigm has to be preceded by the appearances of not one or two anomalies, not many small anomalies but major ones. In order to declare a paradigm to be crisis ridden, what is required is an accumulation of major anomalies, but there is no clear cut or objective criterion to decide which anomalies are major and how many such anomalies must be accumulated to declare a paradigm to be crisis ridden. And in other words, there is no criterion which decides whether a perceived anomaly is only a puzzle or the symptom of a deep crisis.

The issue will be decided by the community of practitioners by the discipline through the judgment of its peers. That is why we have this peer review system and so on. Once the scientific community declares the existing paradigm to be crisis ridden, search for the alternative paradigm begins.

Once we see that, science is crisis ridden, science entered the phase of crisis, then the search for new paradigm begins. Of course, the crisis ridden paradigm will not be given up until and unless a new paradigm, a new theory is accepted in its place.

It is only during this transitional period of search for the new paradigm that the scientific debates become radical; that transition from normal science to revolutionary science when we make a transition, at that time only the scientific debates become more radical.

And during the process of the search for an alternative, the scientific community has to make a choice between competing theories and in this choice, the evaluation procedures of normal science are of no use. For those depend in part upon a particular paradigm and that paradigm is at issue.

The issue concerning the paradigm choice cannot be settled by logic and experiment alone. What ultimately matters is the consensus of the relevant scientific community. In other words, the choice of a theory, as the new paradigm has to be understood in terms of the value judgments which a community of scientific practitioners exercises in the context in which it finds itself. While choosing a particular theory for the status of a new paradigm, the scientific community might advance particular arguments that seek to show that that the chosen theory solves important problems, is simpler than the rest and so on.

But these are all value judgments, since there is no objective criterion to decide which problem is important and what is simple, to what extent intensity of the problem and so on. In other words, that theory is chosen which fits the value commitments of a scientific community.

Hence, the question of choice becomes a question of value. The question of choice no longer remains a question of logic and experiment, rather value judgments. Now, how Kuhn deviates from the entire discourse on scientific methodology, that you just cannot say that science only believes in facts, not values, but the question of choice, the question of having a consensus: Whether India should go ahead with nuclear tests or not? This is not a scientific question. This is absolutely a value based political question, which has got significant implications for international relations and so on. That is why for Kuhn, the question of choice is nothing but the question of value.

Kuhn points out, that the question of value can be answered only in terms of criteria that lie outside the normal scientific tradition altogether and it is that recourse to external criteria that most previously makes debates on paradigm, paradigm shifts, more revolutionary in nature. Thus a paradigm choice cannot be explicated in the neutral language of mathematical equations and experimental procedures. But in terms of specific perceptions which are

scientific community as a social entity entertains what it considers to be the basic value of its professional enterprise.

Putting it succinctly the ultimate explanation of a theory choice is not methodological, but sociological in nature. It is not scientific, but sociological in nature. It cannot remain within the canons of scientific method rather it is more sociological in nature that is what Kuhn suggested. Hence in Kuhn's schema, the idea of scientific community as a social entity is axiomatic.

That is to say, according to Kuhn, if the term paradigm is to be successfully explicated, then scientific communities must explain scientific practice in terms of paradigms, paradigmatic changes, paradigmatic shifts, are explicated in terms of a particular scientific community that builds consensus and so on, which shares the paradigms and brings about paradigmatic changes.

Thus, the concept of a scientific community is basic to the concept of a paradigm model. The concept of scientific community can be explained according to Kuhn, only in sociological terms, and hence the ultimate terms of explication of scientific activity are sociological in nature.

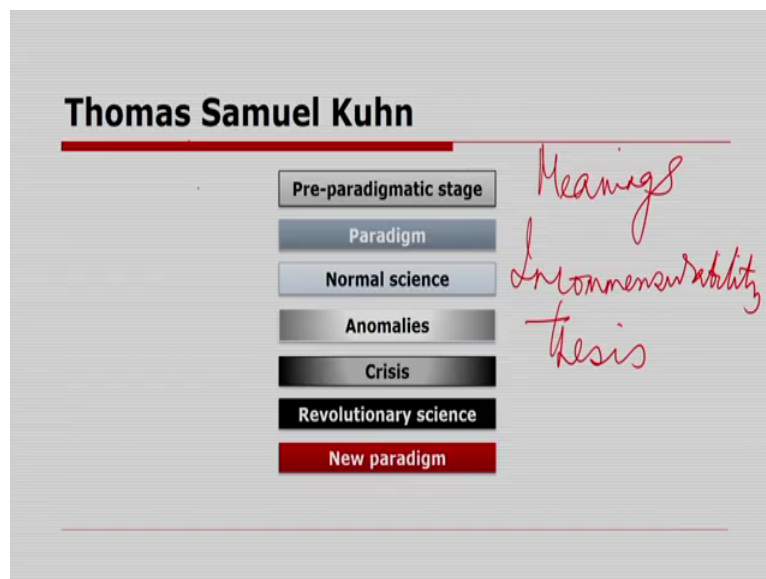
Say the question of choice is the question of value, then it becomes more sociological than crude scientific in nature. As positivists argue that science believes in facts, science does not believe in value commitments. If I say this is a computer, this is a fact. If I say, this computer looks beautiful, then I add value to it, science does not believe in these values, science only believes in facts.

But when I say the question of choice according to Kuhn is the question of value, then it becomes more sociological in nature, and hence the ultimate terms of explication of scientific activity, as well as scientific community are sociological in nature.

Then what is the relationship between the old paradigm which is overthrown and the new paradigm which succeeds it? Kuhn's answer to this question is extremely radical. According to Kuhn: in no obvious sense, can one say that the new paradigm is better or truer than the old one. Kuhn maintains that the two successful paradigms cut the world differently, they speak different languages and putting it metaphorically the world changes when a paradigm changes.

Kuhn says, the transition from a paradigm in crisis to a new one, from which a new tradition of normal science can emerge is far from accumulative process one is achieved not merely by an articulation or extension of the old paradigm rather, it is a reconstruction of the field from new fundamentals; reconstruction that changes some of the fields most elementary theoretical generalizations as well as many of its methods and applications.

If you look at this that the world changes when a paradigm changes: you look at when India became independent, there was a transition from colonization to decolonization, our world changed because our paradigm also changed, because our paradigm changed from being colonized to decolonized; to become independent. That apart, Kuhn contends that the two paradigms talk different languages, even if the same terms are used in two paradigms, the terms have different meanings.



What can be said in the language of one paradigm cannot be translated into the other language. Based on this reason, Kuhn claims that the relationship between the two successive paradigms is incommensurable.

No wonder Kuhn compares paradigm shift to a gestalt switch- with this the idea of scientific progress as a continuous process and the idea of truth as the absolute standard, stands totally repudiated, rejected. Kuhn advances what might appear to be an undiluted relativism, according to which truth is intra-paradigmatic and not inter-paradigmatic, that is to say, what is true is relative to a paradigm and there is no truth lying outside all paradigms.

Then what we have discussed in this lecture? We have discussed Kuhn's delineation of methods of science, which have significant implications for social science research today. We

have discussed how the life of every major science passes through two stages namely the pre-paradigmatic stage and the paradigmatic stage, and within the paradigmatic stage, how normal scientific tradition is practiced. Normal science is nothing but a puzzle solving activity, it is a tradition bound activity and so on.

And then when normal scientific tradition encounters anomalies, it enters the, enters the phase of crisis, and once science is crisis ridden, it always tries to search for a new paradigm mediated by revolutionary science. If normal science is a tradition bound activity, then revolutionary science is a tradition shattering activity.

In the next lecture, what we are going to discuss - we are going to make a comparison between called Karl Raimund Popper and Thomas Samuel Kuhn. We will try to make a distinction between Popper's methods on the one hand and Kuhn's methods on the other. Thank you.