INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI

NPTEL

NPTEL ONLINE CERTIFICATION COURSE
An Initiative of MHRD

Science, Technology and Society

By
Dr. Sambit Mallick
Department of Humanities and Social Sciences
Indian Institute of Technology, Guwahati

Let us come to the second week module on this faces new course on science technology and society and what we have done till now in the last week we discussed the way technology science and society have been conceived and the way we have tried to bring about a critical relationship between these three forces of production MMA science technology and society through different models, through different perspectives on HTS namely the linear model ,the integrationist model ,and the embedded model.

And we have discussed this I mean the similarity between linear and the integrationists model suggests that both these models the treat science technology and society as separate entities well as the embedded model suggests that no science and technology are not autonomous activities they are very much a part of society they are very much a part of social formation that is why there relationship between science and technology is symbiotic in nature okay, and then we discussed how technological determinism, the notion of technological determinism can be challenged how epistemology can be combined with ethical considerations to bring about philosophy of science.

And that is the job of HTS scholars to bring about a conglomeration of philosophy of science history of science and sociology of science and there on we moved on to how technology is not neutral the neutralatity of technology depends on design and control through ,I provided such an example so the construction of the new breeze the way public roads in india design and soul and then having discussed the ontological questions what is being ,what is existing what is in reality in store we have come to what ought to be what should be what is prescriptive what is

normative image and there we discussed must own normative structure of science much onion institutional imperative Martin Ian it was of modern type okay.

That is why the ethos of science the way Martin visualized okay is the effectively stoned complex of values and norms which is held to be binding on the man of science and these norms are expressed in terms of prescriptions and in the normative frame work edge of all the then that after prescriptions I mean the nonce which are legally bound preferences I mean which preferences come under the scope and ambit of motivational values are non-ideal and preferences which come under preview of institutional values and norms and ideas okay.

And then we discuss the goal of science which is the extension of certified knowledge then we discuss the imperatives of science which derive from the goal and its methods when I say when Martin said method he meant in terms of empirically confirmed and logically consistent statements of regularities okay this is very important next I science always starts with science always starts with not thinking it observable fact but also verifiable in fact that is why I gave you the example that if I say I have been a ghost.

I just cannot say that that is real because I have observed that Ghost which may not be verified okay under the scientific real then we discussed how much and flags for institutional imperative in terms or fore of science namely universalism communism disinterestedness and organization.

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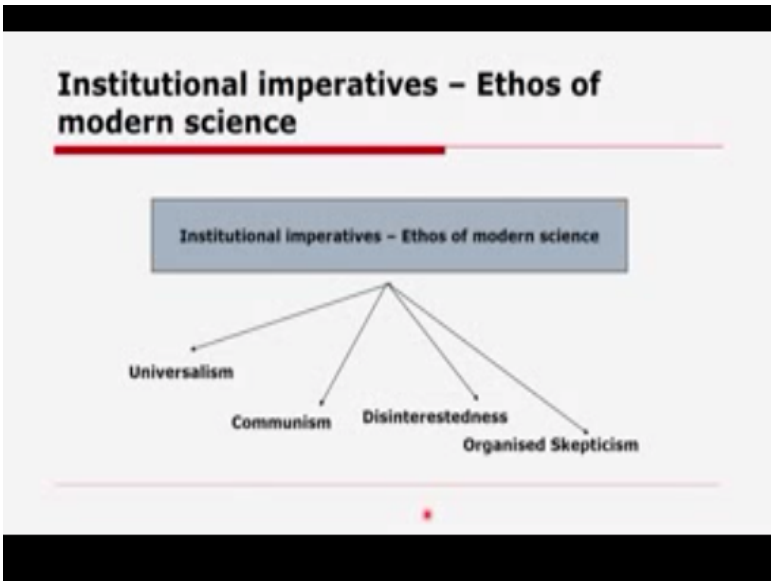

Okay now we have discussed the ontological questions and then we discuss the normative questions the normative questions have dealt more with the goal of ways okay if you look at these four it took Ethos of modern times universalism community game and disinterestedness s they refer to the goals of when edge organized skepticism is not only a goal of science.

But also met methodological mandate okay, then you keep on postponing your judgment unless and until all vaccinated okay from this let us move to from the goal of science. Let us move to the methods of science what may be the possible methods of science it is not like that.

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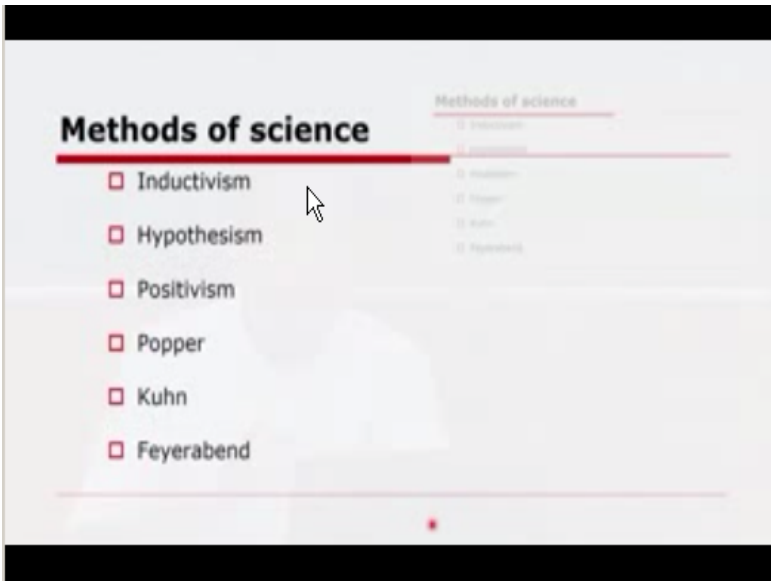

There is the method of there may be multiple methods of science we will discuss one by one and please remember the question what is the method of science is as old as science itself I stuttered what about a detailed answer to this question and his theory of scientific method like this like his scientific theory exercised tremendous influence till around 60th century however with the emergence of modern science and modern philosophy in 17th century the question what is the method of science was raised a phrase.

I mean when I talk about 17th century 18thcentury it is very important to understand the context of the Enlightenment the context of rationality, the context of critical thinking, the context of reasoning capacity ,the context of Industrial Revolution mean changes in the mode of production mean the ability to interrogate the hitherto existing structure cells of structures including religion it was also a question I mean question questioning the dominance of Church at that okay this question .

What is the method of science or what may be the possible methods of science okay the very attempt to provide a satisfactory answer to now the question amounted to decisive break with the past as it implies a dissatisfaction with the entity and theory of scientific method with us have in the 17th century the birth of modern philosophy STS scholars there be English okay ,what kind of methods that we find.

So far as science is concerned what kind of methods that the practitioners of sign for it is very important then they amount from different registers different eg lecture and political trajectory

somebody may say no X is motile X is a man that is why all men are mortal premise a is number one is X is motor premised number two as an evidence X is a man the conclusion is all men.

And a particular instance to arrive at a concrete generalization is of attributed to in the finished image if I just revert it if I alternate I say no my premised number one should be all men are water my premised number two should be X is a man then the conclusion is X is motor that is hypothesis because I am trying to start with a hypothesis all number okay, that is a different question that till I and you are alive.

How can I come to a conclusion that all men are mortal that is a separate question altogether we will come to this point later that is a delimited situation that is such questions have been raised by the proponents of inductive is not a charged hypothesis among many counts including this one okay, and then we come to then we will discuss positivism then we will discuss systematic finality now but called proper then we will discuss the structure of scientific revolutions in terms of I mean propounded by from school and then we will discussed how parable tried to reject any kind of method.

I mean any kind of hitherto existing net okay, that is why we wrote against method let us start let us do this exercise one by one okay in the whole period of three centuries as I said that in the 17th century we witnessed the birth of modern philosophy of science then we fight if we look at this in the whole period of three centuries from the 17th century to the 19th century two huge standout prominently as answers to the question what is the method of things these three centuries they try to answer to this question .

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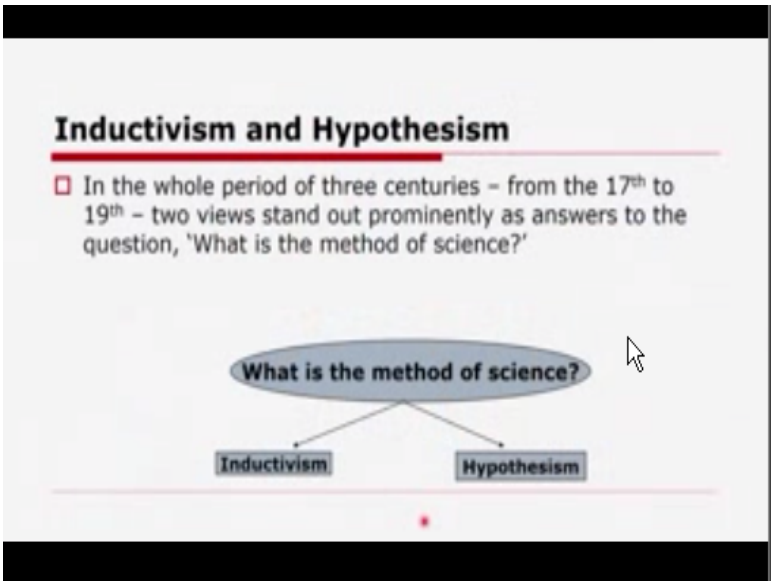

What is the method they may be the first view I mean I mean those two views which stand out prominently okay one inch inductances and the other hypothesis.

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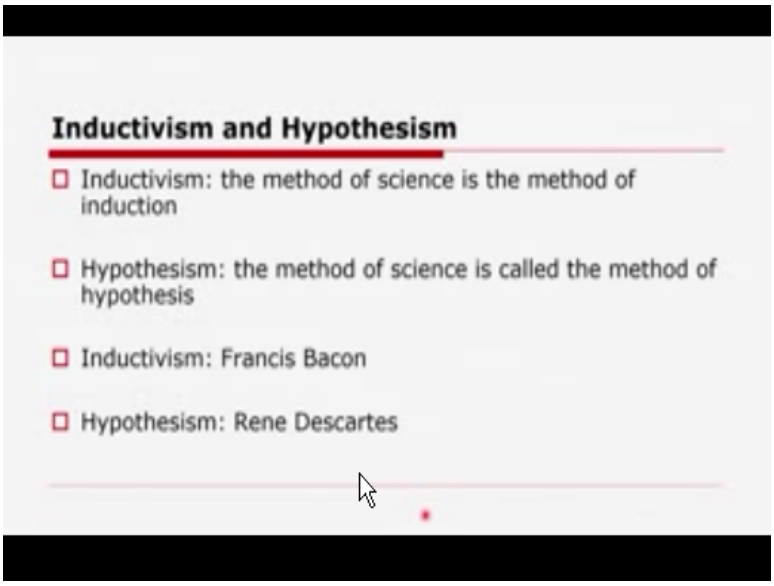

Inductivism if you the first view I as I said is called in definition according to which the method of science is the method of induction the second view is called hypothesis regime according to which the method of science is called the method of hypothesis okay Inductivism is pioneered by Francis back nowhere as hypothesis is not is pioneered by Rene Descartes.

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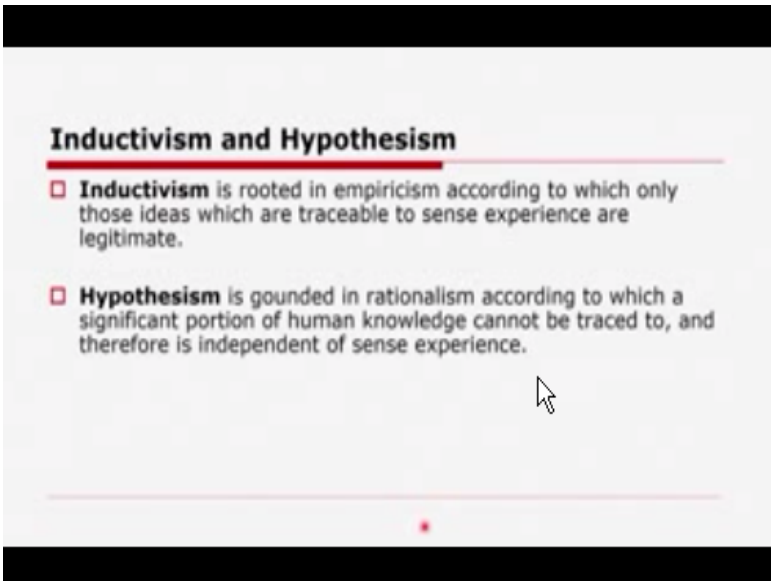

The two view sought to provide two models of scientific method treatment okay, I mean when I say the two views sought to provide two models of scientific method perhaps for this reason one can speak of the Baconian model I mean and the Cartesian model of scientifically.

I mean in despotism is known as the Baconian model whereas hypothesis is in means known as the Cartesian model of scientific investigation is rooted in impressed according to which only those ideas which are traceable serious experience at legitimate what is unprecedented the imprecision is based on experience whatever I experience, I create knowledge out of Maya I mean that is why Inductivism is rooted is based on the empirical method the method here I mean the knowledge is based on the knowledge born out of experiences.

That is why I said in Inductivism is rooted in imprecision according to which only those ideas which are placed able to send experience as legitimate okay, in science we always try to make legitimate explanation valid excellence if you look at hypothesis in it is grounded it is rooted in rest knowledge according to which a significant portion of human knowledge cannot be traced to and therefore is independent of sense experience it is interested suppose you will find in this space.

Now that is portal electron can we see this then we see that it is beyond our sense experience now mine I mean this portion of human knowledge is not proceed I mean cannot be and therefore is the independent of Sense experience it does not imply that there is no proton or really there is more than an electron here but it is beyond our standard scale that is why we

deploy the method of rationalism I mean reasoning capacity if empiricism is based on experience they rationalism is based on reason okay.

Let us say I repeat Inductivism in is rooted in empiricism according to which only those ideas which are traceable to sense experience or legitimate whereas hypothesis engine is grounded indefinitely in according to which a significant portion of human knowledge cannot be traced to and therefore is independent of Sixth Sense experience okay, we let us start with inductive is then we go ahead with hypothesis and then we will try to see what kind of controversies these philosophical schools of thought they try to bring about Inductivism looked up in certainty.

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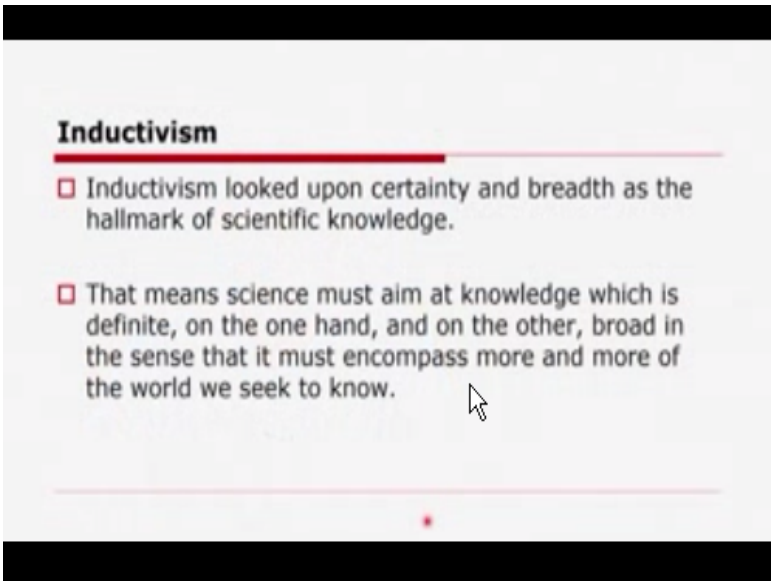

And breadth the hallmark of scientific knowledge there are two things one is certainty and the other breadth it implies that science must aim at knowledge which is definite which certain on the one hand and on the other it must have breadth I mean it must be broad in the sense that it must encompass more and more of the world we seek to know .

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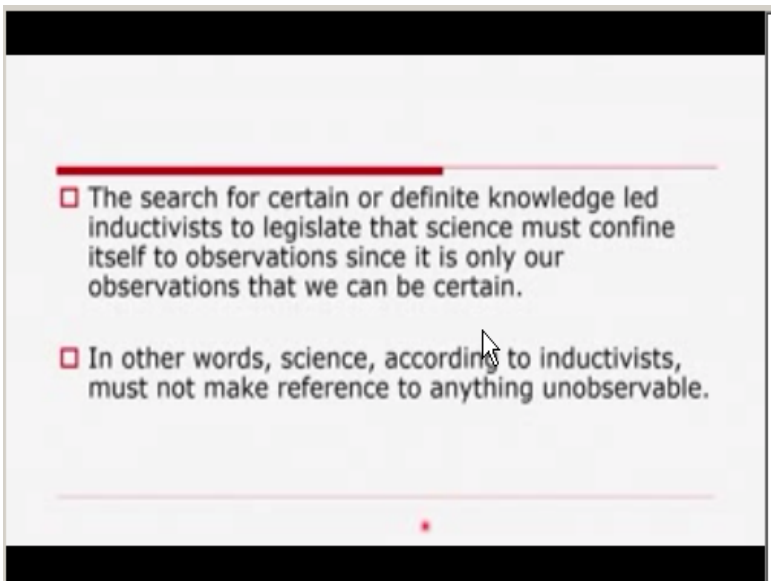

Okay the search for such for certain or definite knowledge laid inductivists to legislate that science must confine itself to observations since it is only our observations that we can be certain other words science according to inductivists must not make reference to anything on unobservable whatever I observe i must believe in that whatever is whatever cannot be observed and must not believe in and must refrain from believing in this kind of thing.

If you look at this is this is one is certain okay I mean only observe it if you look at it okay object and which is unobservable we do not want to ah I mean in definition they do not want to consider to be legitimate.

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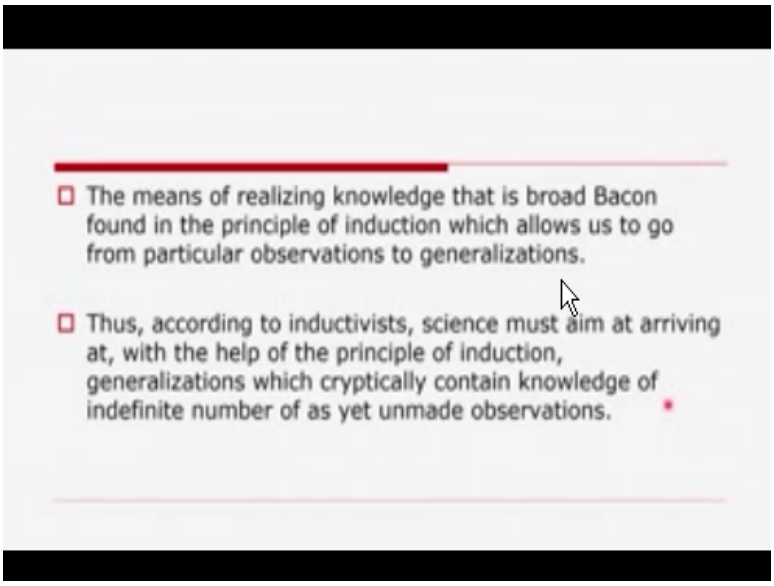

It implies or this the means the means of realizing knowledge that is brought back and found in the principle of induction which allows us to go from particular observations to general ideas that is why I said at the very outset that if I say X is motor premised number one remains number two is X is a man and the conclusion is all men are phone okay, some particular instance okay I tend to arrive at a complete generality suppose.

If I say X is a X is motile X is the tiger ,that is why all men are mortal I cannot make this statement this is not a valid statement in logic in inductive nature okay ,I must try to provide certain evidence to come to a complete conclusion to arrive at a complete generalizes perhaps for this reason according to in the finished science must aim at arise aim at a rising it with the help of the principle of induction generalization switch cryptically content knowledge of indefinite number of as yet unmade observations.

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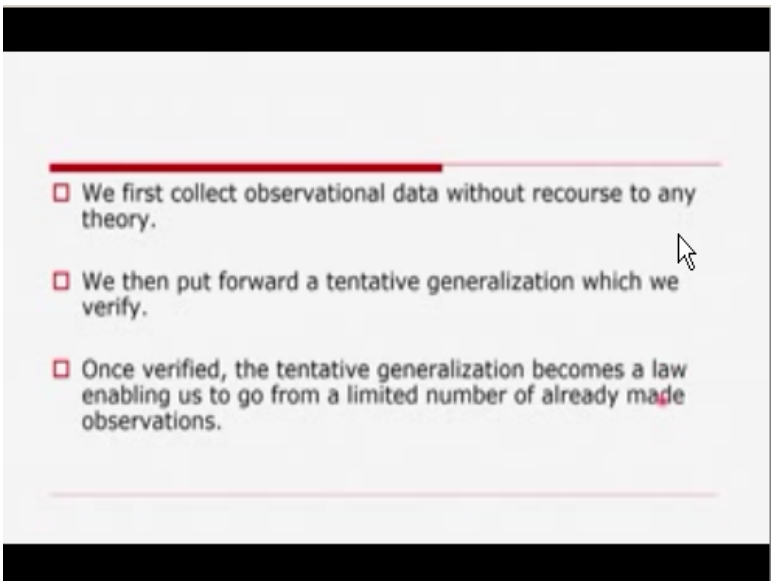

I mean then what kind of method that inductive is now proposed that it starts with observation then we put forward the tentative generalization which means verify I mean observation in X is mortal Socrates is mortal okay, that is an observation then we put forward a tentative generalization which we verify that Socrates is motor which requires verification and once it is verified the tentative generalization becomes a law enabling us to go from a limited number of already made observations.

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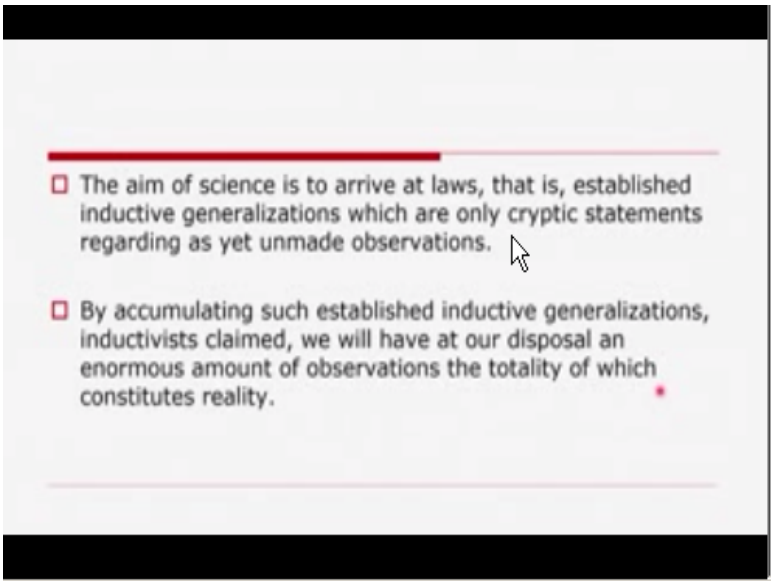

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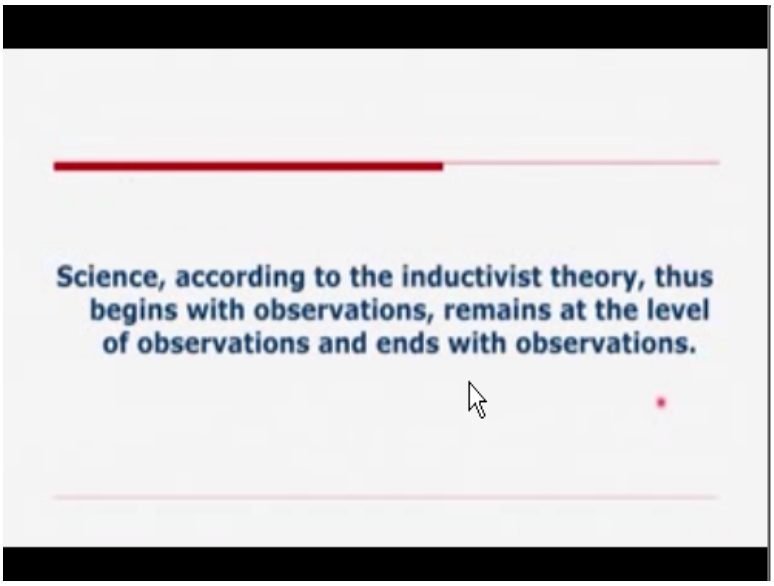

Okay I mean then it starts with observation then tentative generalization and then conclusion okay observation tentative generalizes and then culprit okay ,we first collect observational data without recourse to any choose our observation may deviate from the existing theory our theories may not support our observable data we must first try to collect observational data without any recourse to without recourse to any theory we then put forward a tentative generalization which we verify and once it is verified that particular tentative generalization becomes zero.

Okay I mean conclusion the aim of science the broad aim of science is to arrive at large okay in mathematics suppose in physics in chemistry in while we always try to arrive at launch that is established in the generalizations which are only cryptic statements regarding as yet unknown observations by accumulating such established inductive generalization inductive exclaimed that we'll have at our disposal an enormous amount of observations the totality of which the totality of which constitutes a reality okay first for inductive or according to the in distinguished schema according to the induct image theory sign begins with observation remains at the level of observation and ends with observation.

Things cannot go beyond object lines and I have set large and arrived set conclusions only on the basis of objects if it is unobservable then the theory the law that we make okay it is not legitimate it is not valid then what we have discussed till now the inductive is in looked upon certainty in breadth the hallmarks of psychology if according to the in distinguished schema the hallmarks of scientific knowledge are certainty and breadth then according to hypothesis engine

the hallmarks of scientific knowledge include novelty and depth okay, that is to say science must aim at knowledge which is new okay one is novelty and depth.

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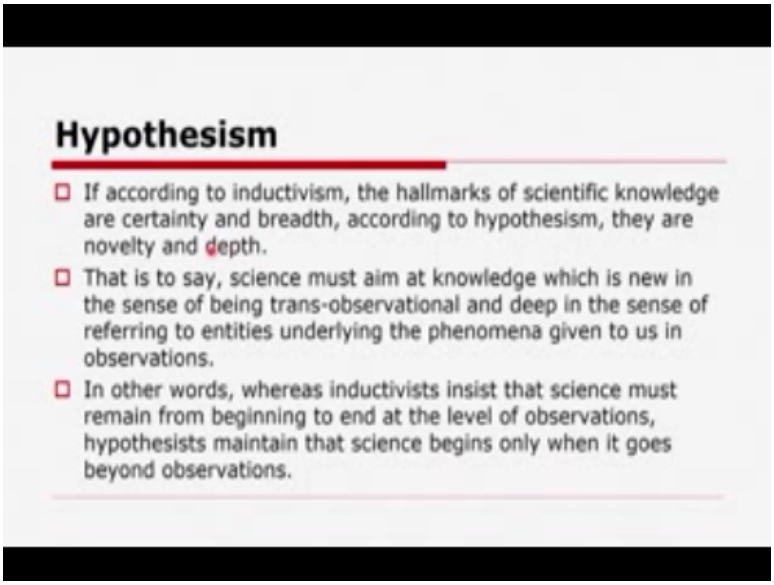

Okay that is to says science must aim at knowledge which is new in the sense of being trans observe vessel and in the sense of referring to entities underlying the phenomena given to us in observation if in the in distinguished science begins which observations remains at the level of observations and ends with observations then for the proponents of hypothesis so for the proponents of nationalist philosophy of science begins only when it goes beyond observations it is trans observational in nature okay.

That is why it must be new okay, it must go beyond observation ok and it also must be B in the sense of referring to entities underlying the phenomena given to us in observing ok in other words whereas in distinguished insisted science must remain from beginning to the end at the level of observation hypothesis maintain that science begins only when it goes beyond observations.

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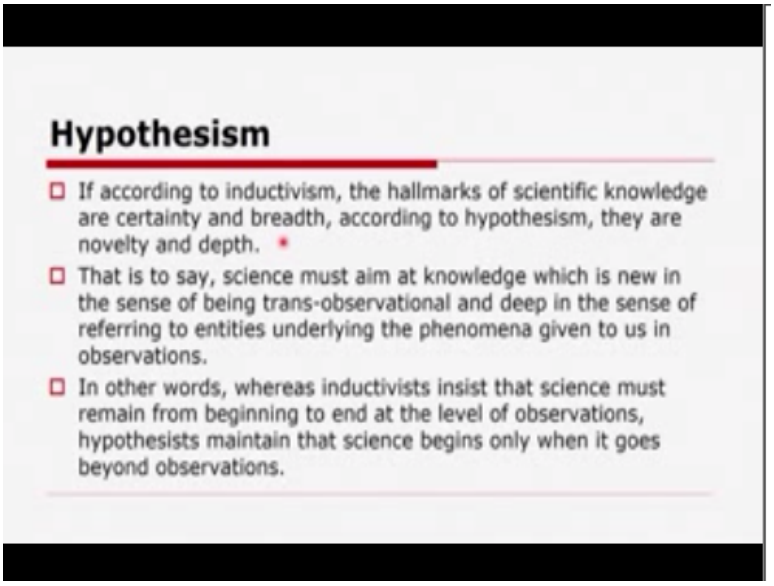

According to hypothesis in genuine science must not remain content to its generalizations based on of generation but must seek to explain observations in terms of the unobservable or deeper entities On processes the term hypothesis in 17thcentury meant a statement regarding unobservable entities and processes though today by hypothesis will only mean a tentative solution to a problem or hunch I mean what is a hypothesis is a tentative solution to a problem or hunch in research methods what we huge people very often say that to know you have to prove your hypothesis or disprove your hypothesis.

But HTS scholars that do not believe in proving or disproving one psychosis hypothesis may be tested right or wrong if you are die hard in proving or disproving your hypothesis then it hinders the tradition of cumulative knowledge production. In this sense in the in the hypothesis schema genuine science must not remain content to its generalizations based on observations but must seek to explain observations in terms of the unobservable or deeper entities and processes okay well there is no place for hypotheses in the in the finished scheme.

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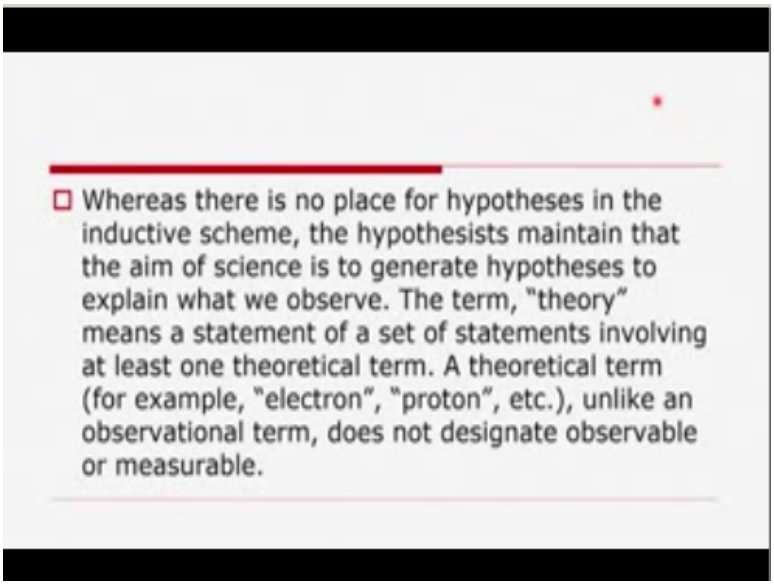

The hypothesis maintain that the aim of science is to generate hypotheses to explain what we observe the term “theory” implies a statement of a set of statements involving at least one theoretical term a theoretical term for example electron or proton unlike an observational term there is not designate observable or measurable next what I initially said this place everywhere you will find proton or electron.

But you just cannot observe them it goes beyond observable that is why we tend to use retinol is philosophy of science to observe them ok it is not simply through observation that we can say that the range electron or product okay, what is it theory it Theory refers to a set of interrelated propositions or ideas intended to explain facts or events I mean a theory always depict some kind of interrelated propositions or ideas.

It must have a purpose it its purpose lies in its improved if its purpose lines in providing adequate explanation to a to an event or adequate explanation for an event for any program of excel for any fact, for any value and so okay adequacy if you look at slightly deviate from this but now adequacy is based on different parameters but adequacy is based on two panned adequacy is based on or adequacy is examined at the level of meaning and also at the level of statistical generalization when I say statically generalizations I mean I want to follow a more quantitative positivistic I mean we will discuss positivism later on and also this I mean positivistic and pre positive.

Which dictates when I say adequacy can be examined in terms of terms of meaning or adequacy is based on the level of meaning okay what we see in the post positivist at the level of interpretive interoperating school of thought propounded by Max Weber we do this when we when we discuss verstehen school of thought okay that is why it is more qualitative but the controversy still remain whether add equation can be judged only at the level of statistical generalizations or only at the level of meaning general meanings we see okay ,but we must mediate to okay the distinction between.

The crude distinction between the die cut remind yourself or the dichotomy that that it is poses that these two terms poses I think we must try to knowhow or the distinction between adequacy based on meaning and the distance and adequately based on statistical generalization is not rigid but for okay then let us see let us see how inducting is suggested that no if you cannot observe something then it is not real and what hypothesis claim that no knowledge is generated only when you go beyond observations okay it is not simply that only when you go beyond observations that is not real that also may be real that is also real but inductive is its argue that no that is not real if you go beyond observances okay inductivists are basically increased and imprecise maintain.

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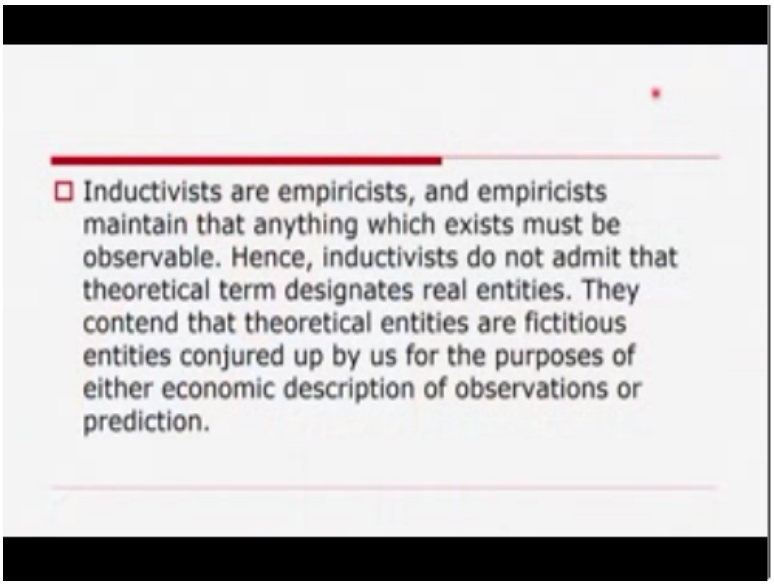

That anything which exists must be observable hence if in the fists do not admit that theoretical term designates the real entity okay they contain that theoretical entities are fictitious entities when conjured up by us for the purposes of either economic description of observations or prediction.

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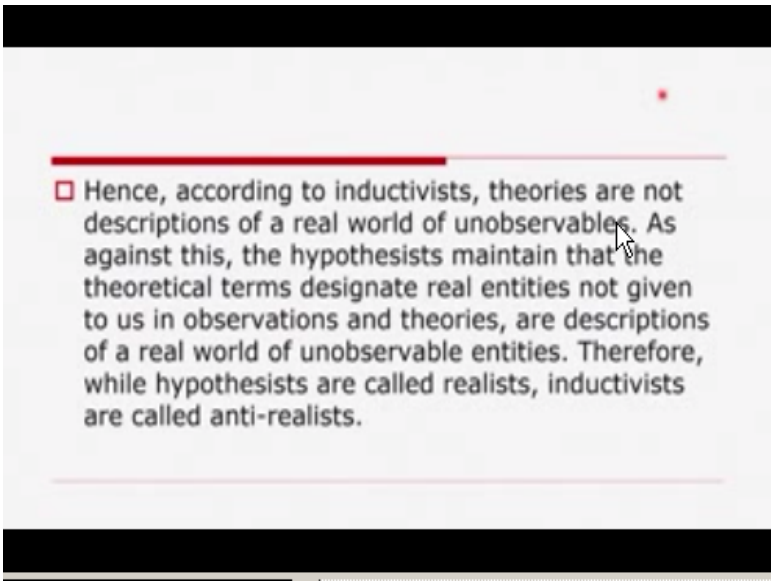

Hence according to inductivists theories are not descriptions of a real world of unobservable as against this the hypothesis maintained that the theoretical terms designate real entities not given to us in observations and here each are descriptions of a real world of unobservable entities therefore while hypothesis are called area list inductive circled anti-realist why precisely because but for hypothesis they always try to see the that the reality.

Which is implicit in the unobservable entities that is why they are called released inductive is they do not believe in anything which is unobservable even if that is real like proton electron and so on okay ,that is why they are called and Inductivism and hypothesis region.

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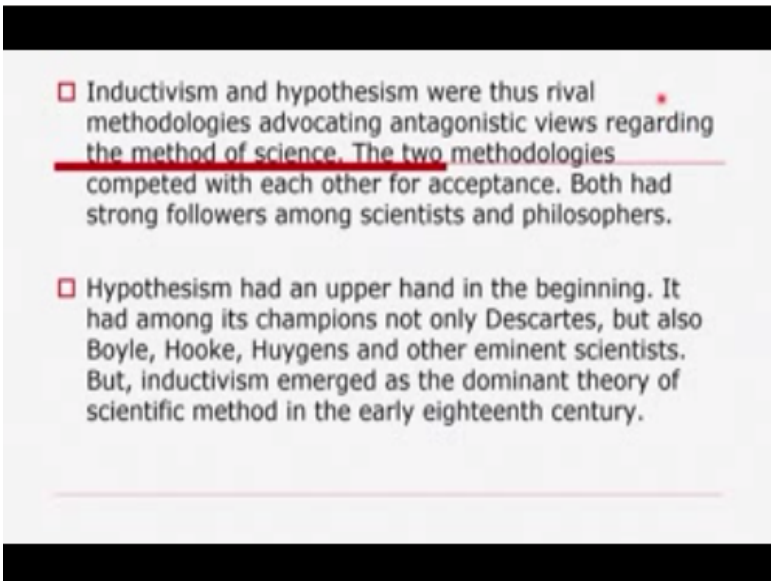

Where the rivals methodology advocating antagonistic views regarding the methods of science these two methodologies competed with each other for acceptance both had strong followers among scientists and philosophers as well it is interesting I mean you will find both scientists I mean natural philosophers fine in fact science was coined By Wavell in the 19th century early aridity used to be known as natural clocks and the kind of philosophy that we see today that was a breakaway I mean that got separated from that natural philosophy we call it moral philosophy but that is why you will find from the branches of both natural philosophy .

And moral philosophy dead they support some of them is a supported industry widget as well as some of them supported to hypothesis no doubt we come to who supported which group will in the beginning what we find that hypothesis in has an upper hand it had among its champions not only Descartes, but also Boyle Hooke or Huygens and other eminent scientists but Inductivism emerged as the dominant theory of scientific method in the early 18thcentury.

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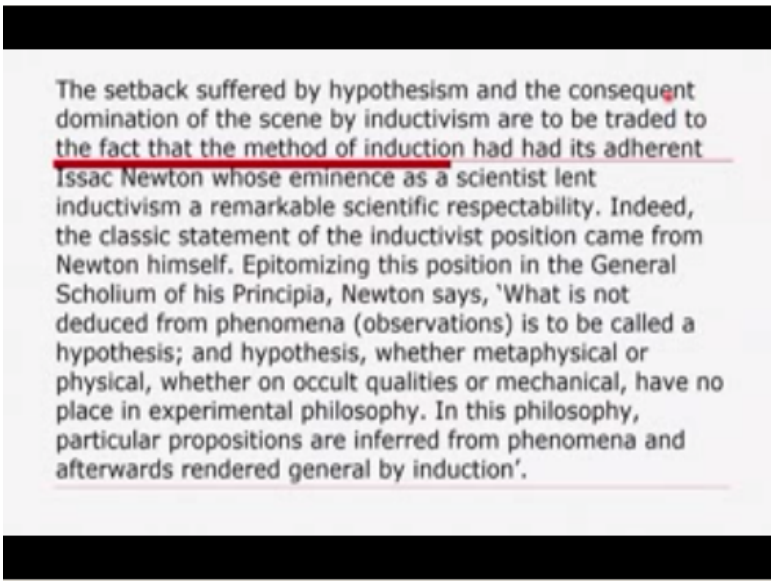

How ok the setback suffered by hypothesism and the consequent domination of the scene by Inductivism are to be traded to the fact that the method of induction had it adherent term I Sir Isaac Newton who eminence as a scientist lent Inductivism a remarkable scientific respective because Newton was in favor of Inductivism he was he subscribed to the inductive is to method okay, indeed the classic statement of the inductivists position came from Newton himself epitomizing this position in the general column of his Principia Newton says I mean the principle I mean this is a work which drew attention of the entire globe.

Where Newton says what is not deduced from phenomena I mean observations is to be called a hypothesis and hypothesis whether metaphysical or physical whether an occurrence qualities or mechanical have no place in experimental philosophy in this philosophy particular propositions are inferred from phenomena and afterwards rendered general by index when Newton discussed in his magnum opus principle in that term know what is not reduced from phenomena observations to be called the hypothesis and hypothesis.

Whether metaphysical or physical whether on occurrence qualities or mechanical has no place in experimental truth okay then he always subscribed to at least in this statement he subscribe to the philosophy of inductive or the inductance matter of course .

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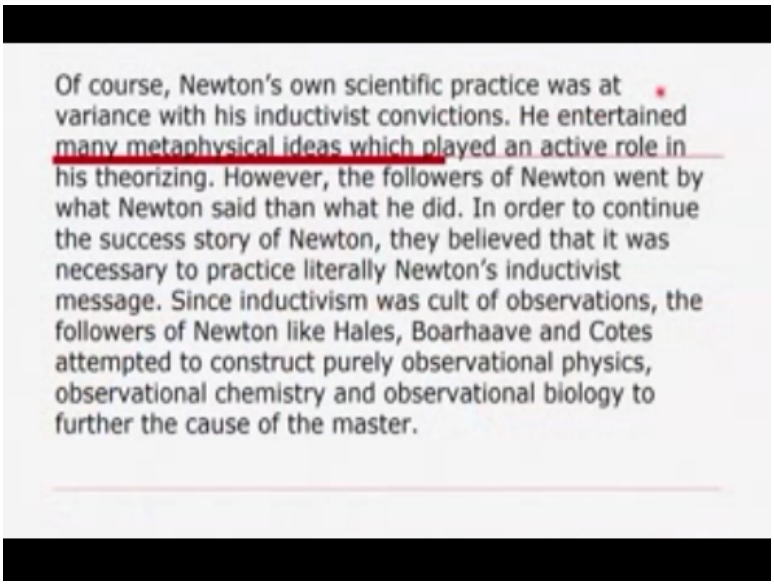

Newton's own scientific practice was at variance which is in the finished conviction he entertained many metaphysical ideas which played an active role in his duration I mean if you go through the writings of Newton you will find you however the followers of Newton went by what Newton said then what he did it is interesting to see okay, in order to continue the success I mean in order to continue the success story of Newton the followers of Newton believed that it was necessary to practice literally Newton's inductivists message which he said here that what is not deduced from phenomena or observations is to be called a hypothesis.

And I possess is whether metaphysical or physical whether an operant qualities or mechanical have no place in experimental philosophy okay, in this philosophy particular propositions are inferred from phenomena and afterwards they rendered general by induct okay this is very important to understand okay I mean the followers of Newton okay they followed this statement as an inductive east message since Inductivism was called sub observations the followers of Newton like Hales, Boarhaave and Cotes attempted to construct your real observational physics observational chemistry and observational biology to further the cause of Newton I mean no further for the purge of the master okay.

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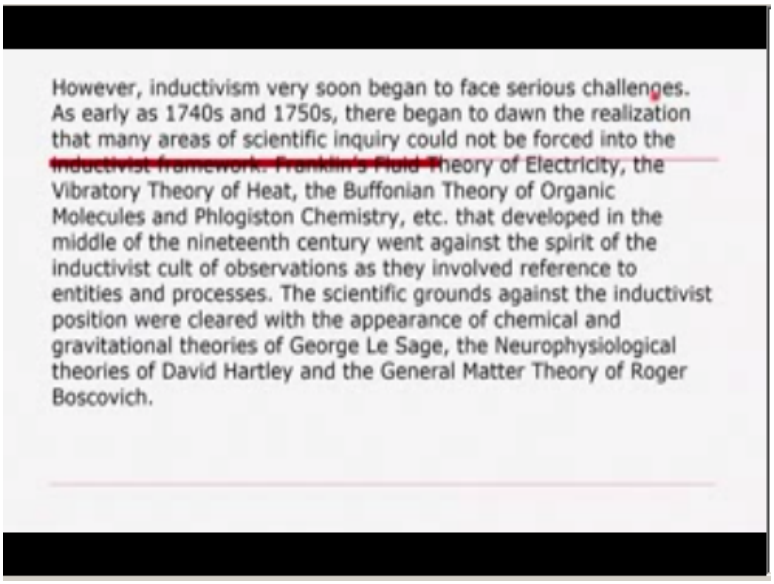

However inductive is a very soon began to face serious challenges as early as 1740 and 1750 there began to dawn the realization that many areas of scientific inquiry could not be forced to the inductive East framework for example if I give you certain examples that Franklin third theory of electricity the vibratory theory of heat the Buffonian theory of organic molecules.

And phlogiston chemistry etc that developed in the middle of the nineteenth century went against the spirit of the inductivists cult of observations as they involve reference to entities and processes the scientific grounds against the inductive expulsion were clear with the appearance of chemical and gravitational theories of George Le sage the Neurophysiologic theory of David Hartley and the general method theory of Roger Boscovich.

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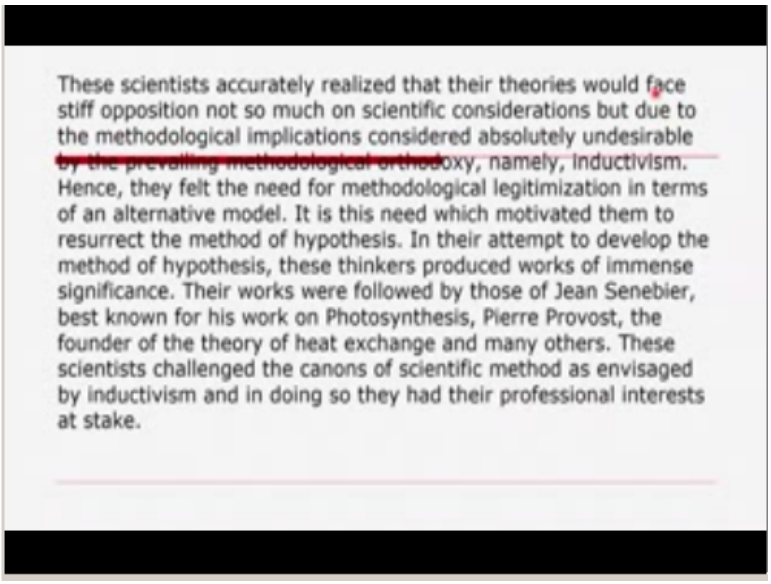

Okay and these theories and this scientist accurately realize that their theories would face stiff opposition not so much on scientific considerations but due to the methodological implications considered absolutely undesirable by the prevailing methodological orthodoxy namely inductive okay that is a methodological rationale assumed greater significance in this context that is what we discussed in the context of organized skepticism that that it is not simply an institutional obligation but also methodological obligates okay it is a methodological rationale perhaps for this reason these scientists which I mean the other scientists like Paige Utley Boscovich and others what they did they felt.

The need for methodological legitimizes and in terms of an alternative model it is this lead which motivated them to resurrect the method of hypothesis try to understand now the transition from industry vision to hypothesis and in their attempt to develop the method of hypothesis these thinkers produced works of immense significance their works were followed by those o jean Senebier, best known for his work on photosynthesis Pierre provost, the founder of the theory of heat exchange and many others these scientists challenged the canons of scientific method.

I mean analysis of scientific method I mean at that time that was in Inductivism these scientists challenged the canons the rules of scientific method as envisaged by the proponents of Inductivism and in doing so they had their professional interest also at stake because of the ways in which you find that there is this method they also became ideologically oriented these personal attributes professional attribute ideological attributes became more significant in this

context apart from these challenges from the protagonists of the method of hypothesis the method of induction also faced.

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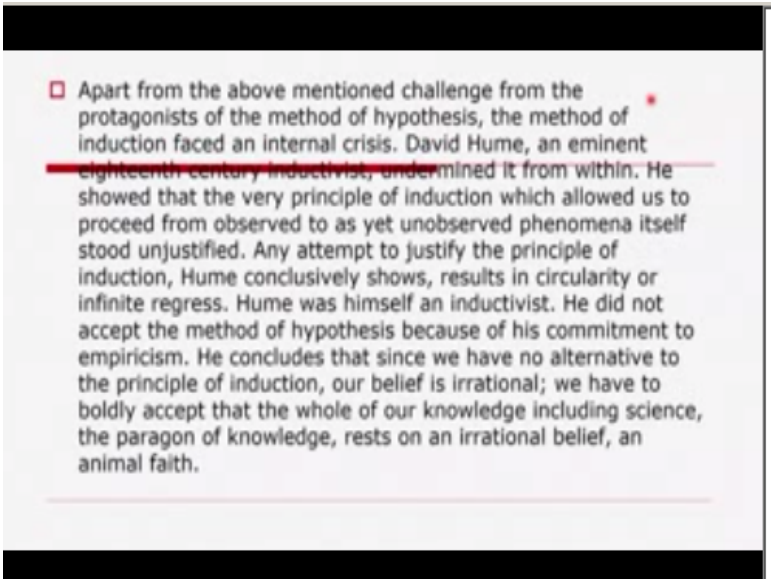

And an internal crisis there is David Hume, an eminent 18th century inductee reached undermined it from weeding it is interesting you humor is a prominent inductive is no doubt about ok he saw that the very principle of induction I mean principle of induction I repeat from particular instances to and I were to concrete generalization and the principle of hypothesis that we have discussed that is from a general statement to a particular instance okay that ship the way Hume sold that the very principle of induction which allowed us to proceed from unobserved to as it unobserved phenomenon itself stood unjustified any attempt to justify.

The principle of induction Hume conclusively shows results in circularity or infinite regress Hume was himself an inductive history did not accept the method of hypothesis because of his commitment to empiricism which is based on experience which is based on observations okay and he concludes that since we have no alternative to the principle of induction our belief is irrational we have to boldly accept that the whole of our knowledge including science.

The paradox the paragon of knowledge rests on an irrational belief an animal faith okay why did he say that that the very principle of induction which allowed us to proceed from observed to as it on observed phenomena itself stood unjustified and any attempt to justify the principle of

inductance results in circularity or infinite problems if I tell you students that know if I tell you friends that all crows are black.

I have seen on coach can I make this statement that in logic that as in all coach I have seen asking one crow two crows three crows 100 crows thousand close ten thousand close one lakh crows one core crows but then have I seen all crows in the world then in the inductive schema which you thought let know there may be some crow which is non black people very often say that no all swans are white have I seen all swans in the globe there may be non-whites one in this sense how many how many observations are adequate to come to a conclusion there is a limitation of such kind of statistical general ideas right.

I mean one must understand the under what kind of limiting condition we want to say all crows had black or all swans are white okay in essence though he himself was an inductivists the conclude now that since we have no alternative to the principle of inductance our belief is irrational and we have to boldly accept that the whole of our knowledge including science the paragon of knowledge rests on an irrational belief and animal faith.

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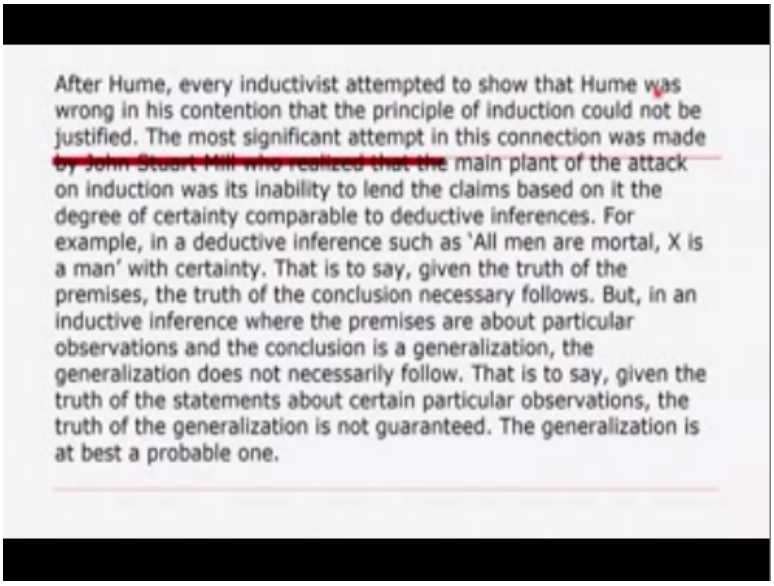

After Hume , the followers of Newton I mean the elective is attempted to soul that Hume was wrong in the in his contention that the principle of induction could not be justified I mean precisely because they wanted to go ahead with only Newton I mean those who rejected you the most significant attempt in this connection was made by John Stuart Mill who realized that the main point of the attack on induction was the inability to blend the claims based on it the degree of certainty comparable to deductive inference for example for example in a deductive inference such as all men are mortal X is a man with certainty .

That is to say given the truth of the premises the truth of the conclusion necessarily follows but in an inductive inference where the premises are about particular observations and the conclusion is a generalization the generalization does not necessarily follow that is to say given the truth of the statement about certain particular observations this portion is very important please that is to say given the truth of the statement about certain particular observations the truth of the generalization is not guaranteed the generalization is at best of probable own ok this is for John Stuart Mill.

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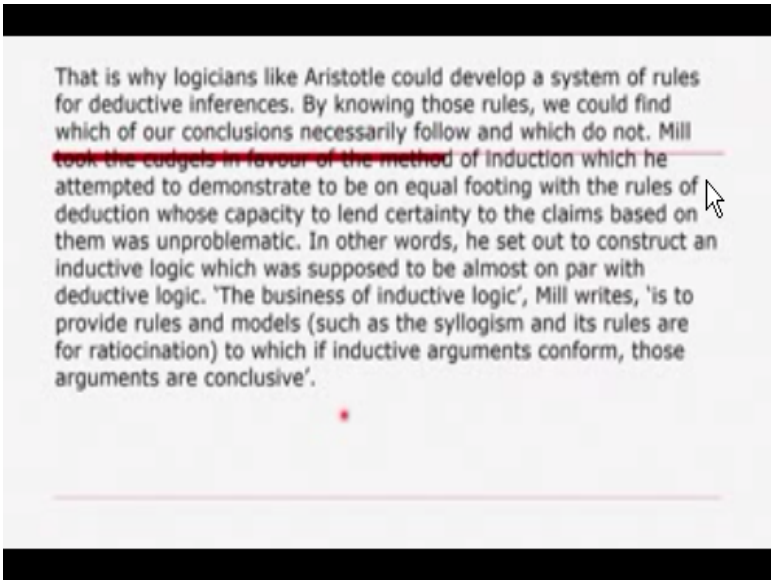

That is why logicians like Aristotle could develop a system of rules for deductive inferences okay John Stuart Mill also did that that by knowing these rules we could find which of our conclusions necessarily follow and which do not necessarily for John Stuart Mill took the castles

in favor of the method of induction which he attempted to demonstrate to the to be on equal footing with the rules of deduction whose capacity to length to the claims based on them was unproblematic in other words John Stuart Mill set out to construct an inductive logic.

Which was supposed to be almost on par with deductive logic he let me caught me here that the business of inductive logic is to provide rules and models such as syllogism and it is rules are for ratio nation to which if inductive arguments confirm those arguments are conclusive I mean syllogism means mediate deductive inference that is found in logic if somebody is very interested in logic for that people can refer to immediate deductive inference mediate deductive inference and syllogism is alternatively known as mediate deductive inference and those rules which even destructor you could develop a system of rules for deductive inferences in logic .

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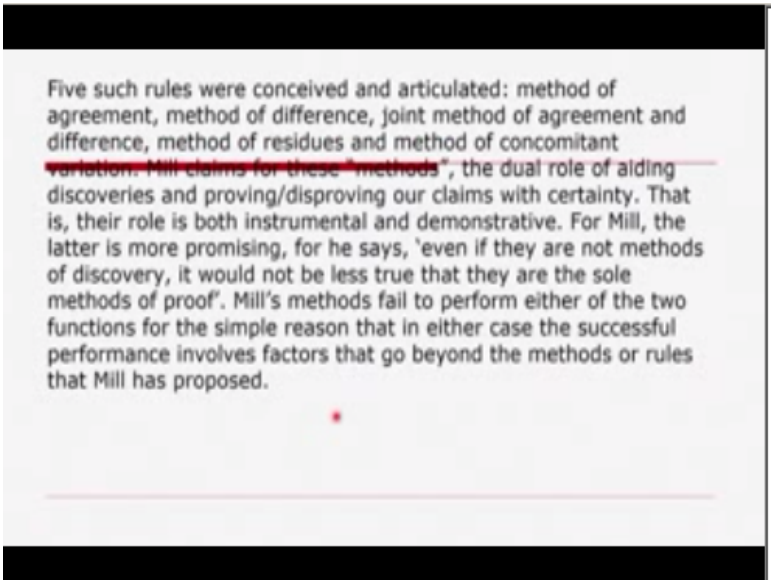

Okay we will try to provide five such rules he conceived of 505 such rules and attic related what are those five points on the method of agreement two the method of difference three the joints method of agreement indifference four the method of residues and five the method of concomitant various and milk help for these methods the dual role of aiding discoveries and proving or disproving our claims with certainty that definitely okay that is their role is both instrumental and dimensional their role when I say when Neil said their role is instrumental.

I mean their role is goal-oriented their goal must the their accent must have instrumental rationality there they must have a bowl oriented social accent and so and when he said their role is must be demonstrative I mean whatever claim that you are making you must be able to show it now to the wider public to the wider scientific community but for I mean for me even if even if there is there is there is no method of discovery it would not be less true that they are the sole methods of proof I mean Mills method failed to perform either of the two functions for the simple reason that in either case the successful performance involves factors that go beyond the methods or rules that Mill has proposed.

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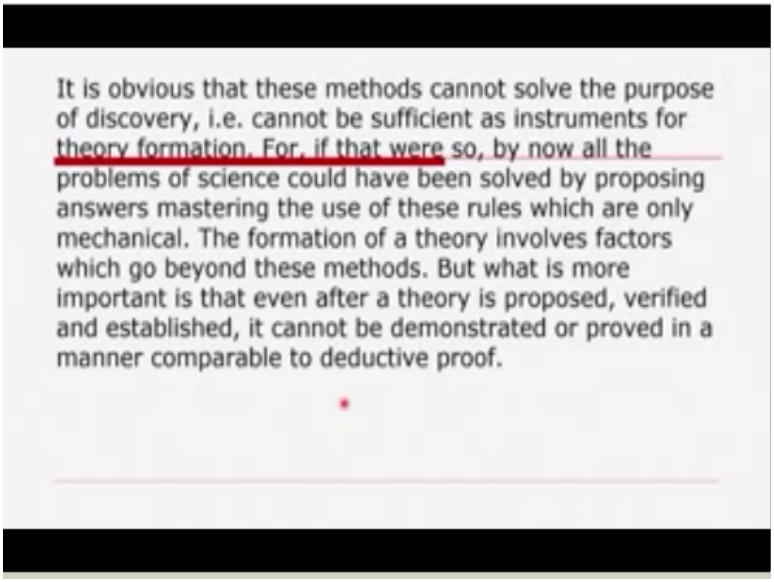

It is obvious that these methods I mean the method of agreement the method of difference the joint method of agreement and difference the method of residues and the method of concomitant variations okay, cannot solve the purpose of discovering that is cannot be sufficient as instrument for uniformity for if declared.

So by now all the problems of science could have been solved by proposing answer mastering the use of these rules which are only mechanical the formation of a theory involves factors which go beyond these methods but what is more important is that even after a theory is proposed verified and established it cannot be demonstrated or proved in a manner comparable to deduction proof.

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