PREJUDICE, IMAGINATION AND SCIENTIFIC KNOWLEDGE

"We must not add wings, but weights and lead to the intellect, so as to hinder all leaping and flying"

— Bacon

Scientific knowledge appears to be the most definite and precise type of human endeavour on which we can trust confidently. It is supposed to be founded upon the solid ground of observation and experimentation, devoid of any speculative non-sense—free from any bias or wild imagination. I shall try to show in this paper that the role of prejudice and imagination in the construction of scientific theory is not negative as has been mistakenly undermined by both Bacon and his modern contemporary successors (I mean the inductivists). On the contrary they play a very important constructive part in scientific knowledge. The idea of bias (theory)—free knowledge is a myth.

I: The Doctrine of Prejudice revisited — Bacon

No one had a lower opinion of the past than Becon to whom all theoretical achievements must be forgotten to make our mind free before any observation. Everything which Aristotle taught is declared to be not only false but also a poison which pollutes the mind. Bacon has a twofold theory for scientific knowledge : (1) The negative aspect of it is the doctrine of error or idol. It amounts to saying that there are some in-built existing ideas in us which can in unwatched way vitiate our knowledge. We should get rid of this rational infra-structure so as to get a free and open mind for observation. (2) The more positive aspect is that of a sensible scientific method by which we can discover true theories from pure observation. This method he suggested is the method of induction, which only can gurantee us certain knowledge. In this section I shall explain and evaluate the first and wait for section II to discuss the second.

The predispositions which Bacon fears to have a bad influence over any open method of discovering true knowledge are classified by him in a fourfold scheme. He calls them (1) Idols of the Tribe, (2) Idols of the Cave, (3) Idols of the Market place and (4) Idols of the Theatre. The (1) refers to our tendency of finding order where there is no order. This is a general human disposition to see things in the light of pre-existing order. The (2) however is not a part of general human error, but we also have on top of the defect of the (1) type—peculiar individual prejudices. The (3) is the most interesting and most troublesome of Bacon's system. It is connected with the convention of language. We understand the nature of different concepts (e. g. up-down or rest-motion) as absolute contrast and do not realise their relative character. The classification due to linguistic convention excludes certain possibilities of thinking. The (4) is the most condemned error of all, Bacon warned us that various large theoretical systems which have been advised by many great authors of the past have an influence over people's understanding in interpretation of facts. The Aristotelian system, for example, blindly spins out a handful of theories out of certain a priori ideas as the spider spins the web out of its body.

How deep-rooted are these errors? Alas ! we are born with these mischievous propensities — we can try however to counteract and control the evil tendencies of error. In our attempt to neutralise them we see that the '(1)' is innate, the '(2)' may or may not be innate – a good brainwashing may help, the '(3)' is due to social intercourse and the '4' is a result of listening to the authority, paying attention to the ancients. Although these propensities cannot be comepletly eradicated Bacon did not despair. He optimistically believes that we can nevertheless try to neutralise them by will-against intellectual tendencies by willful commission and looking at things in a free way. Scientific method (inductive method, to be sure) should begin with trying to purify language and construct scientific language by some familiar concepts and not by establishment of certain laws. The scientific concepts for exampl, 'force', 'mass', 'acceleration'—should be clarified in their meaning. But the meanings of these concepts again depend on the theoretical assumptions. It is thus a paradoxical situation Bacon has landed into, we cannot have a good

science before we have a scientific language firmly established. In this endeavour he did not trust Aristotelian logic. His mistrust is not because the syllogistic method cannot prove anything deductively but rather on the ground that it is better to be piece-meal, unsystematic, than to construct a syllogistically spinned out system of ideas to avoid the possibility of idols. He denounces this highly interconnected system of intellectual imprisonment. Syllogistic logic consists mainly of demonstration-taking some universal premise to be true. The dominant influence of Aristotle is the justification of a proposition by referring back to this universal premise. The method of science, however, is to examine the premise, not the conclusion, to question the validity of the universal on the ground of the particulars given. To draw particulars from the universal is a trivial job.

This doctrine of error is regarded by many[1] as the pivot of Bocon's philosophy. It condemns all mistaken views as anticipations and therefore as prejudices. The word prejudice (idol) was initially introduced to have a specific philosophical sense but later on it includes all theories not established by observation. Bacon emphasises that error is a result of prejudice and prejudice has its root in dogmatic acceptance of any conceited view. Error and sin are almost equated, though accidentally, by the rise of Puritanism[2].

Now to come down to the task of what Bacon exactly meant by 'idols' and their function. We see that they appear to be names of classes of prejudice which, like robbers unwatched, try to deprive us of our reason. But names are not theories, since we may determine them at our will. Some educationists acclaim Bacon's demand for making us aware of our in-built prejudices which vitiate our mind. Some others, however, like S. T. Coleridge, points out that the word 'idol' is given only to give a pedantic air to his reasoning—what he means by it in fact is no more than what Plato means by opinion (doxas) which lies in between realm of scientific knowledge on the one hand and that of ignorance on the other. But I think the idol is not just opinion but some degenerated form of it. Plato anyway never condemned opinion in the way in which Bacon vehemently attacked idols as detrimental to scientific knowldge. Opinion in the form of popular knowledge, in fact, has to be accepted sometimes for practical

purpose when more systematic scientific knowledge is not found. But idols of Bacon definitely have no such positive role-it is the most unwelcome hindrance in the pathway to knowledge. Every opinion i. e. any undemonstrated view—anything that the intellect worships blindly—is an idol. Bacon's reply to Macaulay's question 'what is a prejudice'? was that *all* hypotheses, all doubtful views, are necessarily prejudices of those who believe that they are true. In his introduction to the *Novum Organum* Bacon contends that the path followed by the ancient did not lead them to certain knowledge because the inductive machine could not operate due to the evil effect of the prejudices. The mind of these people were polluted with atomism and other such metaphysical theories. He repeatedly declared that once one leaps to a too general axiom one is holding to an axiom which is no longer certain and therefore possibly false and therefore a prejudice. So, here we find a very interesting function of the doctrine of prejudices—all past failures can very well be explained by it. It explains not only future theories but past theories as well. When a scientific theory is refuted, this doctrine makes it convenient to explain it by referring to the fault of the man who operates it leaving the machine untouched. Thus it makes the the theory of induction irrefutable. Methodologically it supplies us with a new criterion or line of demarcation between science and metaphysics. Science is certain, definite and based on observation; whatever else is uncertain, doubtful and speculative does not belong to scientific knowledge, it makes metaphysics. This purgative or negative way to knowledge was found to be connected with the true spirit of learning. The doctrine of purging mind of all impure ideas before waiting patiently for certainty and truth to emerge has almost a religious devoutness. No doubt it has a tremendous superficial impact. As some critic aptly puts it, we may say in short, 'prejudice paralyses science' is Bacon's slogan. He tells us how tremendously difficult it is to overcome the temptation of guessing while observing, and how necessary it is to resist this temptation if one has to make true science.

The origin of error and prejudice can be traced to myth described by Bacon in his '*Wisdom of the Ancients*' (1609). The myth conveys a metaphysical theme. God created mind and the universes on the same level; therefore, learning was natural and

wisdom prevailed among the ancients. Then came the Fall of man-people did all forbidden things like speculation and anticipation, and since then the art of learning degenerated and wisdom was lost. But that is not the last thing; for we need not despair. The elixir of knowledge, the key to the kingdom of science, can be regained by a simple but austere method : by purging mind of all evil effects of prejudices we can purify ourselves to return to the golden age of knowledge once again. Observation, and not speculation, is the real philosopher's stone.

We can see however that Bacon's methodology was never seriously accepted or followed. The myth of the no-prejudice formula can also be exploded as I shall do later. One important thing however can be mentioned about the theory of error. Bacon realised that the problem of observation is complicated and it is difficult to extricate it from the influence of prevailing ideas. He saw the problem of the relation between theory and fact. How to reconcile observation with theory ? It is perfectly possible to find out a new fact which does not confirm with an existing theory, in other words, what would be the relation between a fact and a theory after the latter has been accepted ? Bacon would answer that the new fact would surely confirm the theory as we are on the look out for the confirmation of our theory. This is very likely to cause the danger of seeing facts in a wrong and distorted way, so as only to confirm our theory which may turn out to be false ! Bacon alleges that Aristotle would never have come to the theory of spheres if only he had observed carefully. But it is obvious that once Aristotle's theory is accepted no improved observation can avoid this. The assumption underlying this doctrine of prejudice is that scientists tend to confirm their hypothesis by making observation. But evidently this assumption is unwarranted and dangerous for the progress of scientific knowledge. Scientists test theories not only to confirm them but also to see whether the test refutes them, no matter how much established the theories are.

The idea of the influence of our theories on our observation, the idea that we interpret all observation in the light of our theories, is regarded by many as an insoluble problem (Whewell, for example maintains a similar view). Bacon however suggested

a solution, viz. that we can overcome it by rejecting all theories. This is simply ridiculous. He struck a genuine problem but the solution is not adequate, for we do interpret all our observations in the light of our theories. In case our theories are false they may misguide us. We see the world through them, therefore they are not reliable. To avoid this difficulty the conventionalists totally ignore the point that theory is even related to fact. They regard theory as convenient tool for computation and no fact can force us to abandon them. The inductivists on the other hand believe that we observe facts as they are, unaffected by theories. Both of them cannot satisfactorily explain how scientists can generally agree about facts. Bacon in a remarkable way says that general agreement does not guarantee the truth of the idea, it does not exclude the possibility of everyone being prejudiced in a similar way. But it is more difficult to accept such possibility which goes almost to an absurd extent than to seek for some other logical relationship between theory and fact.

Thus, far from being recondite, the problem of observation is very concrete and difficult from the methodological point of view.

II. Role of Imagination in Knowledge

The naive scientific doctrine of inductivism denounces any scope for speculation in science, its task being only to be a search for true nature discovered by the method of observation and experiment. We again come to Bacon in the sense of tracing this scheme back to him. He made the first systematic attempt to formulate a method of science and also recognise the methodological problem of relating the method of discovery to the method of proof. In both these tasks he foreshadowed all the views of his modern counterpart—the inductivists and resemble them even in his failure. I shall discuss these two points under (a) and (b).

(a) Induction and Anticipation

The negative or purgative task before any intellectual pursuit is that of being first rid of all the prejudices which might vitiate our senses. The more positive task lies in the patient and cautious observation of nature. As we see, unlike the conventionalists Bacon believes that Nature is full of Forms

of Essences which science tries to discover. The Form or cause is apparently hidden in nature—the method of science is to know this *natura naturans* which is manifest in its effects, that is *natura naturata*. In this persuit Bacon differentiated between (1) the method of interpretation and (2) the method of anticipation. Here he can be classed with Plato, Aristotle or Descartes and can be called an essentialist. To a phenomenalist this problem does not exist, for him, science has only to correlate sensation with phenomena. The single instance of Heat as the nature is found in the whole *Novum Organum*, and science has to find out its cause or refer it back to its Form. The method of interpretation is the true method, which can promote scientific knowledge by systematic observation. True theory will automatically emerge out of it which shows the nature of the true cause. There is no scope of speculation or wild guess here. We should be patient in our observation. There is no need to hurry or employ our imagination in our attempt to know nature. All these hurried speculation or guess can be condemned as the method of anticipation. This latter method is short-sighted, it distorts nature and amounts to blasphemy. In the wisdom of the ancients he denounced all anticipations asrapes, vexations and torture, enforcing and imprisoning nature. The method of anticipation is black to be avoided at any cost, the method of interpretation is good, i. e. a white method.

As regards the positive method of science Bacon tried to seek the road form sensation (or singular) to knowledge (or universal). This is a difficult job but he believes that the method of interpretation can do the trick. In part II and III of *Great Instauration* he elaborates this method. The inductive machine as he calls it starts with the systematic arrangement of raw materials or observational data. People look for observable nature and its phenomena to discover in what way nature works behind. Table of presence, Table of absence and Table of degrees represent two natures going together, absent together and varying in concomitant degrees. Summarisation of the different correlations from these different tables give us some predictive ability but does not lead anywhere. For suppose we do not come across some such natures (present, absent or varying together), then there remains no standard of these empirical

observations from which we can get some knowledge. If we have to produce the thing we have to know the cause or Forms underlying nature, otherwise we have to wait for infinity. Thus, Bacon's attempt to construct a real structure of knowledge behind empirical observations leads to disastrous result. The process from nature to Form as Bacon thought is not as easily computable by the inductive machine. The requirement of finiteness thus is to have a finite form after knocking out all other possibilities. Thus Bacon is driven towards some kind of a priori assumption for the Forms which he calls 'alphabets of nature'. These requirements are as the following : (1) Limited number of forms, but then how could we know them by empirical observation ? In case of all Forms, do they reveal themselves ? Form of heat is rapid motion of particles. We observe heat and then get Motion as its cause surely not by observation. (2) Each Form is sometimes observable. The number of observale elements is not infinite. (3) There is one to one correspondence in nature, it guarantees the existence of some kind of Form with actually observable effects. No two or more Forms are responsible for the same nature. There is always one Form for one nature. Each separtae nature requires a different Form. Thus it seems to have a duplicated form of nature almost in the Aristotelian fashion. But Bacon's duplicated universe is not real like Plato's universe, it is only linguistic duplication.

It involves however a serious logical fallacy : from N (nature) $\rightarrow$ F (Form) Bacon deduced $\sim N \rightarrow \sim F$, which obviously does not follow. But he nevertheless struck a very important note, viz. belief in essence or 'real'. In many aphorisms of *Novum Organum*[4] he said that the subtlety of nature is many times greater than the subtlety of the senses and understanding and therefore axioms established by argumentation cannot cope with the discovery of new works. Axioms duly formed in an orderly method from particulars easily discover the way to new particular and thus render science active. "If there be any one to penetrate further, he has to overcome not an adversary in argument, but nature in selection to seek not petty and probable conjectures but certain and demonstrable knowledge". Such a person is a true son of knowledge. he may[5] find an untrodden way to nature's inner chamber. The two methods

employed for such tasks are anticipations *of the mind* and *interpretation of nature*. The first one is ordinary reason, hasty and precocious, the latter is reason elicited from facts by a just and logical method.

The new method for active science : Inductive Machine

There is a little controversy among Bacon's critics about his idea of induction. The confusion arises from Bacon's condemnation of anticipation in almost all places as a natural bent of mind. So he prescribes restricted suppression of them. But in another place he is found to describe Induction as a natural process. It is not any specialist's job, neither is it a complicated process. Bacon cheerfully hopes that once we start afresh from pure observation and in a strictly disciplined way, weigh the data in the inductive machine (somewhat in the same manner as a modern computer is fed) then true theories will be elicited from them. So far so good. But after that he gives a little concession to our intellect ! Overlooking the ironical situation, Bacon permits a little guess or ' Permission intellectus '—better known as 'First Vintage' or 'First Attempt'. It may be knowledge or just an attempt or conjecture threatening to have that dangerous thing, uncertainty, which Bacon dreaded most. It is remarkable to notice that he could not help giving this permission although he denounced any kind of imagination to do any thing with knowledge. He started with a very simplified theory of knowledge with three stages : (i) no preexisting idea, (ii) Pure and orderly observation (presented in the different Tables) and (iii) true theory (knowledge) emerging out of it. The whole process is automatic. If the theory is correct it is due to pure observation, if it is falsified it is because the observation was not pure due to influence of some preguidance and only a little cautious interpretation of nature. If the theory is refuted, the mischief can be referred back to the built-in prejudices working behind our mind, which must have distorted pure observation. In effect, it makes all theories irrefutable, because clearing the mind of prejudices is methodologically a small limitation and psychologically a tremendously difficult job. This is the modern inductivists' plea as well—they unduly emphasise the role psychology plays, in knowledge and therefore need a logic to justify it. That job, alas is equally difficult, as has been shown by the sceptics headed by

Hume. Justification of induction or any empirical theory of knowledge leads to infinite regress and many other logical fallacies.[6]

(b) Discovery and Proof

The most commendable part of Bacon's theory of science is his realisation that science aims at true knowledge of nature. Theories therefore are true description of reality. This is in short his doctrine of constant discovery and also his strongest point. Neither the Schoolmen of his age nor the conventionalists see that discovery of facts is the most important aspect of scientific knowledge. Bacon realised that " it is a peculiar and perpetual error of the human intellect to be more moved and excited by affirmatives than by negatives.....in the establishment of any true axiom, the negative instance is the more forcible of the two." Bacon condemned the conventionalist views as he[7] reared that it may neglect or deny new discoveries which do not fit with older theories. He has a peculiar theory of observation that one does not see things normally as they are, but only as one is prejudiced. That means careless observation also is prejudice.

Observation, however, is not any perception–but perception with a definite objective. Can this objective be defined at all except by referring to any existing framework ? Observation includes the processes of analysis and identification. Observing something as a star or planet, for example, includes classification and identfication which presume theoretical knowledge of at least geometry and astrophysics. What we need therefore is a methodological criterion for discovery of new facts. So although his slogan was ' Do science and do not discuss it ', Bacon tried to give a methodological criterion which however was trivally unsuitable. His criterion of novelty of observation and theory of discovery was found[8] in the context of discovery of magnet— ".....nor was it by philosophy of rational arts, that they were found at least, but by Accident and by Occasion..... altogether different from anything that was known before, so that no preconceived notion could possibly have led to the discovery of them....." Although Bacon did not claim that his criterion is exhaustive, it is of surprise which comes by accident. This however is not an adequate criterion, it is not satisfactory because we can not demarcate between discovery and invention

by it. Neither was he a utilitarian, but only awe-struck naively amazed at the wide and new horizons of science opened before him which he did not understand well.

One of the difficulties of Bacon's theory of discovery is that it is unacceptable not only to any rational philosopher but also to the inductivist who believes in observing facts as they are. Nor does anybody share his belief that novelty is intuitvely observed by an 'empty mind.' Many facts were declared as great novelties but were later found to be slight variations of well-known phenomena. The discovery of new sources of electricity found in steam was heralded as very important but soon ignored when Faraday showed that this was only ordinary (friction) electricity. The opposite case is found in Hertz's discovery.

Another point shows Bacon's criterion difficult; it is that we may be able to characterise novelty by appeal to facts. If the mind is empty, it will not be surprised by finding new facts. Every fact will be absolutely new and therefore no fact will be more surprising or important than another. All discoveries are accidental if they are not aided by theory, but only by induction. But what is the guarantee for discovery then ? Surely there are old discoveries which are not due to sheer luck but results of a theoretical expectation. Deflection of the star light (The Parallax effect) was expected by Einstein, long before the famous eclipse experiment. The expected prediction was based on a belief in the General Relativity Theory. Now, although Bacon's theory of discovery sounds like scientific realism, it does not lead anywhere and turns out to be a false note. He did not clarify what exactly is meant by a 'discovery'. Secondly, what observations sholud be regarded as new and how do we make discoveries ? These questions are neither answered nor even raised by Bacon. No modern inductivists either offered a good theory of discovery to explain their methodology. What they emphasised is discovery of new theories (The universals) which are deduced or induced for that matter from the facts (the singulars). What they need is a logic to go from the singulars to the universals. No attempts to justify this logic however is successful.[9] Both a priori and a posteriori attempts in this connection lead to many logical difficulties. So, we remain exactly at the same point where Hume left us, viz. that it is not possible to claim knowledge about

physical reality or other minds or the past from the phenomenal or the present. The logical gap between the premise and the conclusion remains to be filled by a valid logical process.[10] Otherwise we can claim to have neither a standard of knowledge nor any criterion to distinguish between valid and invalid knowledge. Bacon was too naive to see all these philosophical problems relating to knowledge. The phenomenalists and the sceptics at least saw this important but difficult problem. But the former tried to resolve it into the problem of sensations whereas the latter considered it insoluble.

Bacon foreshadows his logical positivist followers in many basic points about this problem, although he lacks both the high sophistication of the latter and also any logical analysis of the problem of knowledge. He is characterised by a tremendously childish naivety about his strong belief in reality and its easy access to our intellect only if we follow the right method of interpretation. The logical positivists tried different formalistic methods including sophisticated probability calculus which can determine at least the degree in which a theory approximates truth and certainty. But those methods unfortunately do not help much because even if knowledge is elicited from facts or, in other words, even if we accept the passage from the singular to the universal as admissible, the truth value of a universal proposition is alway equals 0 according to probability calculus.[11]

The point in which these modern Baconians resemble their intellectual godfather is that both tried to link the theory of discovery with that of proof. Bacon tried to establish scientific knowledge (opposing the School-philosophers by such attempt) on the basis of an empirical foundation in such a way that true knowledge only can be obtained from it. The contemporary inductivists also believe that scientific knowledge is basically knowledge of empirical laws and that therefore empirical foundation can provide us with the synthetic character (non-empty) of such knowledge. But they moved a further step. What they thought necessary is a logic to prove or justify such knowledge (to face the opposition of the sceptical arguments). In very short, they tried to combine method of discovery with that of proof. But how can we discover new facts, or collect them, without knowing beforehand what we are looking for? In other

words, pre-thinking or theorising precedes any collection of facts including finding new facts. Both, Bacon and the inductivists fail to give a solution of the problem of relation between theory and experiment and saw it the other way round, viz. first experiment (observation of new facts) and then theory. For Bacon, discovery does not appear to involve so many epistemological problems. It is just a part of his dogmatic optimism that proper scientific research must constantly lead to new discoveries.

Philosophically, it has an obdurate realistic note: methodologically it gives, a new mark, a new criterion of demarcation between science and theology or and metaphysics. Science is fruitful and progressive, metaphysics doubtful and dangerous for science. He identifies science with advancement of learning. Bacon was the fierest anti-metaphysician and therefore regarded the idol of the theatre as the most difficult detriment to free observation of facts. Logical positivists share almost the same contempt for metaphysics but for a different reason. They tried to eliminate metaphysics not because it is established by the speculative method as Bacon thought, but because whatever they say can be shown by the analysis of language to be nothing but sheer nonsense. But that difference does not amount much because they almost share Bacon's belief that the task of Induction is 'rendering man's intellect equal with things in nature'.[12] Reducing all meaningful empirical propositions ultimately into some basic propositions is a programme which will eventually eliminate not only all so called metaphysical propositions but also many scientific propositions which speak of non-observable but scientific entities (like statements about micro-bodies). In—consistency found in Bacon was naive and initial, that of modern empiricist's is formal, highly sophisticated and terminal. What I wanted to emphasise is that factual support does not have any logical force by itself to lead to any discovery of new facts.[13] Unless it follows from a framework, it does not have any significance to any scientsit. The letter has a preconceived notion of what he is expecting to find. That does not of course mean that he would ever find a surprising fact which might even be falsifying for his theory. In case he finds such a falsifying fact, he has to look for an alternative theory to explain the phenomena.

Moreover, any empirical theory of knowledge cannot provide

a method of proof. The sceptical argument in this context remains consistent and impeccable. If we believe in accidental discovery of empirical facts, as the mark of scientific knowledge we cannot at the same time have a logic to justify it. We shall see in the next section that there are ample evidences in the history of science where a scientist believes a theory to be true even if it does not have any factual support. It is well-known that the Copernican theory of heliocentric universe has even less factul support than the geocentric theory of Ptolemy except that it is a little simpler than the latter theory but nevertheless it was accepted not because of its simplicity or factual support but as it represents a true description of reality. Realism and not just a mode of speech demarcates scientific knowledge from any other type. This belief in real nature cannot however be expected to be proved to emit certain and demonstrable knowledge. Neither does it need to, because a scientific theory is accepted neither for its weight of factural support nor for its demonstrable character. In fact both the weight of actual support as such and demonstrability make it trivial. For example, we can imagine any accidental generalisation based merely on positive instances, any tautology on the other hand is demonstrable but does not have any informative content. It is verifliable but therefore empty and trivial from the epistemological standpoint. Scientific theories therefore need neither be loaded with so-called factual support nor proved. Both Bacon and modern empirical philosophy overlooked this. The former was quite unware of the problem; the latter however saw and tried to solve it by many formalistic methods and not unsurprisingly failed.

We can discuss in this connection Popper's theory of discovery which explains Bacon's theory as well as the questions which were not explained by the inductivists. Popper admits that there is novelty or surprise in discovery. But an 'empty mind' (devoid of any theory) cannot be surprised. It can be surprised only if the 'newly discovered fact' does not fit with a theoretical framework. The anomaly in the predicted pathways of some planets, for example, leads to the discovery of then unknown Uranus. Discovery is surely a surprise, but that is not wholly intuitive but always relative to some theory. Popper gives a new criterion for discovery. It follows from the consideration that once

a theory is accepted, no confirmation would surpries us. Only by refuting a theory, we know that a new fact is discovered. So refutation of a theory is a good mark of discovery. All great discoveries are refutation. The upshot of this argument is disastrous both for Bacon and for the inductivists. Their emphasis is on confirmation. But the increase of the confirmation of a theory is important only as it makes the discovery which will refute it more important. An experiment on an observation of a fact, for example, which will refute Einstein's special Relativity theory will definitely be regarded as a very important discovery. This criterion of discovery explains two things which are not clearly explained by the inductivist theory. One is the fact that in science we seek for independent tests, the other is that a new fact can only be recognised as new in the light of a theory—an empty mind cannot judge which one is new. Every fact should look alik to him unless seen for some purpose. The idea that discoveries of new facts will never clash with old theories is rather a dream than a theory of Bacon. His realistic essentialism finds science to be a process of constant discovery. That is what he meant by saying that science must be progressive—exploring the mysteries of nature. But this progress cannot be the result of accident on the part of any free and empty mind. It is rather the theoretical scientist than the artisan, rather the hard-boiled 'metaphysician' whose mind is 'polluted' (?) by some existing theory, than the credulous laboratory assistant that makes any discovery or invention. Scientific imagination and 'prejudice' to some extent can only explain that.

III. In Defence of Prejudice

In the previous sections I have tried to show how the attempts to construct a methodology for science in a purely inductive way fail and how they cannot explain many problems related to scientific theory and its relation to facts. generally the assumption behind this is : imagination or prejudice is detrimental to scientific knowledge; progress in knowledge would be guaranteed if we follow the maxim 'do not trust any authority except that of the senses'. It seems that this assumption is unwarranted. It is not only that the role of imagination or prejudice is not detrimental, it is on the contrary essential for any scientific discovery. That can

be sufficiently shown by plenty of examples from the history of scientific discoveries. I remember a favourite phrase used by Popper when he lectured on scientific method : ' a scientist has to be in love with his theory and love is the strongest prejudice'. Surely what he means is that though Bacon is right in saying that we have our own prejudice, this does not mean that we can fully eradicate them, nor that anybody can do science with pure observation and no theory. On the contrary, we cannot get rid of the existing theories or ' paradigms ' as Kuhn calls them.[14] Even our language is infested with theory (Bacon also realised this very important point).

Now if we analyse the idea of prejudice a little more clearly and also consider the important features of scientific knowledge, I can show that the latter can very well be said to be aided by it. The idea of prejudice in general signifies belief in a theory without sufficient rational ground. That means it has a deductive structure. For example, Aristotles's theory of physics is the general premise from which his theory of projectives follows, or Einstein's General Relativity Theory is the premise from which the deflection of star-light would follow. That means that if the conclusion does not follow, i. e. does not tally with observation, then the theory in connection has to show that the theory is wrong. Background knowledge and a scientific tradition always influence any scientific observation and, strictly speaking, there is no such thing as 'pure observation'. All our observation involves some ideal element; or, to be precise in the modern linguistic way, all empirical propositions—even singular propositions like ' This swan is white'—involve universals and therefore go beyond observations.[15] As 'swan' is a universal and as all universals are dispositional, singular propositions can also be called 'theory impregrated', to use Popper's terminology. So the inductivist obsession for pure observation or purely observational language is unjustified : observation always involves some theoretical reference. We cannot get rid of the ghost of theory —it is chasing us down to the bottom of even the simplest possible kind of empirical propositions.

So this search for theory-free knowledge which is the result of passive observation is not fruitful. Observation is not passive but involves active interpretation and has a certain aim. As all

interpretation is a function of imagination, we can not explain the interpretative aspect of scientific knowledge except by referring to imagination.

Now, if we shift the emphasis from facts to theory the situation is totally different. When is a theory or a hypothesis wanted? It is not called for unless it is necessary. It is only when a problem arises that a possible hypothesis is made about a fact, or, in other words, an attempt is made to explain it. No settled phenomenon calls for a theory, only a problematic situation needs a theory. So a scientific theory has two important functions to perform : (i) It must *explain past* events or problms and (ii) it must also *predict* some *future* phenomena. The value or acceptability of a theory is judged by how well a theory is performing these two functions. Of the two competing theories a theory which explains and predicts in a better way is more preferable. Now both explanations and predictions are two logical processes having formal structure. Only active imagination or ingenuity can help construct such a structure. The Corpernican helio-centric model, for example, was highly formal structure, a result of unusual imagination which was not only against an existing theory but also went against observational evidences until Kepler's corroboration by telescope. The theoretical scientist expect the predictions to follow not because of observational facts but because they are necessary consequences of a theoretical framework which he spinned out of his imagination. The greater the imagination the more is the theory rich in its fruitful explanation and prediction. Imagination is an essential component not only to make a theory but also to understand scientific concepts which are highly theoretical. The notion of 'centrifugal force' or the behaviour of the 'microbodies' of matter or 'uniform relative motion' can be understood only with reference to a theoretical framework. In fact the whole of micro-science is a body of scientific knowledge which transcends all observations and therefore is a result of rational imagination. We can see the tremendous effect this kind of knowledge has over our whole philosophical outlook although they speak of entities which are by definition non-observable : in fact all major scientific theories are regarded as fantastic in the beginning, because scientific imagination travels faster than ordinary imagination. Only a little latter the true significance of a theory (which may have been thought as a wild conjucture

when it was first initiated) is realised when the predictions of the theory tally with observation. But that observational support does not surprise the scientist because he has logical grounds to believe the theory. When the eclipse-experiment confirmed Einstein's General Relativity Theory, he was asked by someone what would have happened to his theory if the eclipse-experiment could not tally with his prediction ? He was quite unperturbed and answered "then I would have been sorry for the dear Lord, as the theory is correct". This clarifies another relevant point which is related to this perverted view of observation and theory. The point is that all scientific knowledge aims at finding out the real, their theories are attempts to describe the real, not just instruments for prediction (as the conventionalists say to avoid the justification problem). Moreover, belief in extrasensory reality is not necessarily metaphysical—scientists also imagine many transcendent objects the existance of which are non-observable but real. The ground for such belief is logical and rational.

I wish to explain one more point before I conclude. It is the inevitable question : what are the safeguards that can demarcate active scientific imagination or influence of (prejudice ?) existing theory from wild imagination or a dogmaatic bias ? That can be very well done if a theory prescribes the conditions which may refute it. Only then can we call it scientific imagination. In other words testability is the logical constraint of any scientific theory. The more a theory has factual content the more it is vulnerable, i. e. capable of refutation. I cannot think of any better criterion of demarcation. 'Steel melts at 1500° centigrade' is highly informative and at the same time more refutable than 'there is heaven' which is metaphysical. The latter is metaphysical not because it speaks of non-observable entities but because it does not say under which condition it can be refuted. A metaphysical theory can definitely be distinguished from a scientific theory as the former cannot be tested for its truth or falsity whereas a scientific theory is more acceptable for its rich content or degree of refutability.

These considerations lead us to a view of scientific knowledge which is called by some as scientific realism.[16] I shall rather call it scientific rationalism to go a step further. What I want to emphasise by coining this term is that all scientists are not

guided merely by a belief in reality as the goal for science. It is true that they regard their theories as good approximations to truth. But that is not all. They are also convinced of a rational structure by which observations can be logically interpreted. Leibnitz's 'pre-established harmony' or Kepler's celestial geometrical pattern describe this faith in an overdone artistic manner. But unless there is a mathematical or logical regularity in physical reality, we cannot hope to give a highly accurate picture of it. Scientific theories speak of nomic or physical necessity, and contingency can be computed on the basis of some fundamental mathematical principles. Heisenberg's famous Indeterminacy principle cannot beter Einstein, for example, from his obdurate faith in the real as rational. It almost amounted to a religious faith : as a matter of fact he called it cosmic religion. He said, 'God does not play dice'. Methodologically, scientific theories may refer to empirical facts but they are rational parts of a logical infra-structure that corresponds to the order of cosmic reality.

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NOTES

1. *Bacon's works*—Edited by Ellis & Spedding.
2. *Role of Interpretation in Science*—Agassi.
4. *Novum Organum*, Book I, aphorism 10, 11, 12, 14, 24, 30.
5. N. O. pp. 36.
6. See Karl Popper, *Logic of Scientific Discovery*, Particularty sec I, chap. 1. Also Karl Popper, *Objective knowledge*.
7. *Novum Organum*.
8. *Novum Organum I*, ph. 109.
9. W. von Wright, *Logical Problem of Induction*.
10. A. J. Ayer, *Problem of knowledge*.
    A. J. Ayer, *Central Questions of Philosophy*.
11. See Karl Popper, Logic of Scientific Discovery.
12. *Novum Organum* II, Aph. 19.
13. See 'Realism and Instrumentalism' by P. K. Feyrabend in *Critical approach to Science and Philosophy* ed. by M. Bunge.
14. T. S. Kuhn, *Structure of Revoluion*.
15. Karl Popper, *Logic of scientific discovery*, Appendix X.
16. Popper, *Logic of Seientific Discovery*
    Popper, *Objective knowledge, Conjecture and Refutations*
    D. M. Armstrong, *Universals and Scientific Realism*.

INDIAN PHILOSOPHICAL CONGRESS

ANNOUNCEMENT

The 55th session of the Indian Philosophical Congress will be held at Bhagalpur University, Bhagalpur-812 007 (Bihar) from Oct. 26 to 29, 1980. Professor Nityananda Mishra will be the General President for the session. For details regarding local arrangements Dr. G. D. Jha, Head of Philosophy Deptt., Bhagalpur University may be contacted.

Secretary
Indian Philosophical Congress