A NOTE ON THEORETICAL LANGUAGE AND ITS BEARING ON METAPHYSICO-SCIENTIFIC SYSTEMS

In natural sciences a set of presuppositions constituting a conceptual framework seems indispensable. These presuppositions may be said to be logically prior to the sciences, as they provide a guidline for determining the significance of scientific statements which try to establish connections among the directly observables and also to some extent offer an aid in connecting the observables with the non-observables. These presuppositions are not empirical, but 'speculative', as they are not records of experience. Rather they are used for organising the experiences for the sake of scientific experiments. We may refer to some phrases which are embodied in such presuppositions, namely, '*specific gravity*', '*gravitational field*', '*electrically charged*' etc. These are very often taken as assumptions of some hypothetical entities for establishing predictive and explanatory connections among observables. Of course, general statements in terms of observables are there; but very often they have a limited range of application and even within that range, there are cases of exceptions.

Hempel[1] has explained this point by the example 'wood floats on water; iron sinks in it'. It is a general statement in which the floating behaviour of wood is only recorded. Again, all kinds of wood do not float, and iron of some dimensions would not sink in water. These difficulties may be avoided in many cases by assuming some hypotheical entities. In the above case, the concept of *specific gravity* 's' of a body 'x' is definable as $s(x) = w(x)/v(x)$. Here, 'w' and 'v' are characterised operationally in terms of directly observable outcomes of specific measuring procedures, and so counted among observables.

's' may be defined as a characteristic that is less directly observable, classifying which as a hypothetical entity, we may state a generalisation as 'A solid body floats on a liquid, if the specific gravity is less than that of the liquid'. Here, we can see, the exceptions are avoided and the scope has become wider. The generalization now refers to any kind of solid object and its floating behaviour in any kind of liquid.

The concept of 'specific gravity' is not an empirical concept though it has provided connections among observables in the form of law. Thus hypothetical entities are assumed for the sake of certain advantages in the field of scientific investigations. The philosophers of science call such speculative concepts and the sentences containing them 'theoretical' or 'metaphysical'*.

Following Hempel, we may say that the extra-logical vocabulary of the sciences contains two sorts of terms *observational terms* and *theoretical terms*. We may decide by direct observation whether a particular observational term does or does not apply to a given situation; whereas the theoretical terms do not directly refer to observable entities, rather they are used to explain the empirical generalisations[2].

Let us discuss the problem of 'theoretical terms' in some detail in order to bring out the distinction more clearly. As these terms are devised for systematic connection and explanation of observable phenomena, though they themseleves are non-observable in principle, they cannot have independent meaning without referring to the observables in a specific way. Braithwaite points out that the theoretical terms are used as symbols in a calculus which is to be interpreted as an applied deductive system. So they are meaningful only when they have a particular place in a calculus[3]. The formulae of calculus taken as representing propositions about observable entities are given direct meaning. But the formula containing theoretical terms cannot be given direct meaning as the theoretical terms do not refer to observable entities directly. It is only an indirect meaning that is given to the formula which represents the proposition as the conclusion. Now, if the conclusion is interpreted first, then one has to work backward to the beginning. Thus the theoretical terms are given indirect meaning with reference to the observable facts.

The theoretical terms containted in the proposition 'There are atoms' implies some observational sentences, which being true, this particular proposition would be true and by these obser-

* I do not intend to deal with the relation between concepts, theories and systems in metaphysics as it is a further question needing separate treatment.

vational sentences the meaning of the proposition containing the *theoretical term* would be determined.

Braithwaite says "While the theoretical terms of scientific theory are implicitly defined by their occurrence in initial formulae in a calculus in which there are derived formulae interpreted as empirical generalizations, the theoretical terms cannot be explicitly defined by means of the interpretations of the terms in these derived formulae..."[4].

A theoretical term, therefore, does not have the same status as an empirical term. The reality of the entity denoted by the theoretical terms also cannot be determined in the same way as is done in the case of the observational term. The theoretical terms are meaningful in so far as they have a particular place and use in a theory. One may say that a theoretical term is real if the theory in which it is used is true or the theery serves the purpose. Thus one may answer the question "Do electrons exist really" ? affirmatively as the electron theory is true or serves the purpose of the scientists.

We can see the distinction between the empirical and the theoretical terms now. The former refer to the directly observables and the latter do not. An observational sentence containing an observational or empirical term, according to Hempel,"expresses something that is decidable by means of accepted techniques of observation. In other words, an observation sentence describes a possible outcome of the accepted obervational techniques"[5]. So we may say that a sentence is theoretical if it contains a theoretical term which does not directly refer to any observable. A theoretical sentence expresses something that is decidable by reference to the calculus as pointed out by Braithwaite.

This shows that the empirical and the theoretical sentences are closely connected. The theoretical terms and the sentences are devised for the sake of systematic connection and explanation of observational phenomena. Again the theoretical terms cannot be understood without having recourse to the observables. To explain this connection, the philosophers of science have referred to what Carnap calls '*correspondence rules*', Bridgman calls '*operational rules*' and Reichenbach calls '*correlative definitions*'. An example of correspondence rules may be given in Carnap's words. "If there is an electro-magnetic oscillation of specified

frequency, then there is a visible greenish blue colour of certain hue ". Here, something observable is presumably connected with a non-observable micro-process. Thus, by correspondence rules, one may understand a set of rules connecting the theoretical terms with observational terms. We may also note that the explanation cannot go to the extent of replacing theoretical terms by observational terms, Carnap himself has pointed it out in the following lines :

" Is it not possible to interpret a theoretical term by correspondence rules so completely that no further interpretation would be possible ? Perhaps the actual world is limited in its structure and laws. Eventually a point may be reached beyond which there will be no room for strengthening the interpretation of a term by new correspondence rules. Would not the rules then provide a final explicit definition for the term ? Yes, but then the term would no longer be theoretical. It would become a part of the observation language. The history of physics has not yet indicated that physics will become complete, there has been only a steady addition to new correspondence rules and a continued modification in the interpretation of theoretical terms. There is no way of knowing whether this is an infinite process or whether it will eventually come to some sort of end "[6].

Carnap holds that the distinction between observable and non-observable is a matter of degree. An explicit definition by means of empirical procedure may be given to a concept such as 'length' — because it can be directly and easily measured, and it is not likely to be modified by new observations. But, for a concept like 'electron' such strong correspondence rules to define it explicity would not be found. Concept like 'electron' in Carnap's opinion should be kept theoretical and open to new observations in view of the fact that they are far removed from simple, direct observations[7].

Thus, though theoretical sentences are related to obesrvational sentences, they cannot be exhaustively interpreted in terms of accepted observatioual language. For this peculiar characteristics, it has been pointed out by many thinkers along with Carnap that the possibility of new rules of correspondence interpreting the theoretical terms in some novel ways is not only possible, but very often welcome also.

As an alternative view, we may mention that the theoretical terms are also referred to by some philosophers[8] as *'transcendent'* because like the usually accepted transcendent concepts theoretical terms are also concerned with entities which are 'non-observable', in the sense of being outside the scope of normal observational techniques. The difference between these two types of terms cannot be overlooked as the theoretical terms are used in natural sciences for proper explanation, systematisation and connection of empirical phenomena. It is true that the theoretical concept cannot be fully explicated by the help of observational sentences but they would be held as *'non-referential'* if the observational sentences they imply turn out to be mostly false. It may also be pointed out that no such *' correspondence rules '* in the sence we have discussed can be devised to connect the ' transcedent terms ' with the ordinery observational phenomena. In fact, Hegel among some other philosophers holds that their ' absolute ' or ' God ' would exist even if no empirical evidence comes forth in support of them.

However, there is striking similarity between these *' theoretical terms '* of natural sciences and the *' transcedental terms '* in the Kantian sense. Both of these types of terms are connected with experience. The transcendental concepts in the Kantian sense (like the concept of causation) are such that without them experience would not be possible. Again, they are a priori concepts as they do not arise from experience. But the theoretical terms need experience ready-made for application and they cannot be applied to sense-impressions as the *transcendental concepts.* So the theoretical terms for their acceptance need some empirical evidence though in an indirect way. On the other hand the *transcendental terms* are in no need of experience for their acceptance.

Theoretical concepts and the sentences containing them thus have a unique character. They are non-empirical or speculative though closely connected with the empirical phenomena as they are used in scientific discourse in systematising and connecting the empirical phenomena for predictive explanation. The philosophers of science call these sentences metaphysical though in a different sense of the term. These *theoretical sentences* however should not be taken individually as each of them is only a part

of a '*theoretical system*'. A theoretical system comprised of these theoretical sentences provides a conceptual framework or, in other words, a metaphysical theory for a particular scientific system.

Let us take up Carnap's view in this connection in some detail. Carnap has classified all sorts of questions into (a) those which arise within a given system of concepts (b) those which are about this framework and hence are all out of the realm of framework. The first sort of questions are answered by sciences or in our day to day life by the help of the methods appropriate to the field. The second sort of questions are answered in various ways in differant metaphysical works which are concerned with issues of whether or not to embrace and use a given conceptual framework of ideas. Carnap says further that when one of the conceptual frameworks rather than the other is used and adopted, the mode of scientific investigation is given shape and direction which would, however, have been different if another conceptual scheme had been taken up. Carnap also holds that this propoganda for a *conceptual scheme* has appeared in metaphysical works in the misleading form of discussion reqarding the reality or existence of general class of entities corresponding to the fundamental ideas of the system of concepts in quesion. Accordingly it seems as if the metaphysicians are concerned with entities like space, time, number etc. In fact, they are only trying to provide best frameworks for the sciences.[9] Following this line of thought we may say that a metaphysical theory is concerned with questions about conceptual frameworks of sciences-which the theoretical system deals with.

Hempel has distinguished the sciences from a metaphysical theory or a *theoretical system* by characterising the latter as that which consists of significant non-analytic and non-falsifiable sentences[10]. Popper, while distinguishing science and metaphysics, characterises science as consisting of non-analytic significant sentences which are falsifiable and metaphysics as consisting of those sentences which are significant, non-analytic and non-falsifiable[11]. Here falsifiability has been used as the criterion of the empirical character of scientific statements. A non-analytic sentence would accordingly be empirically significant or scientific if and only if it is possible to be refuted by experience or falsified by experience[12]. The falsifiability of a sentence can be

provided by way of the verification of the denial of the sentence to be tested. Accordingly the statements which are not thus falsifiable by experience are non-scientific. Again, a system of such sentences would be scientific, that is, empirically significant, if it is falsifiable,, that is, "... if it divides the class of all basic statements unambiguously into the following two non-empty sub-classes. First, the class of all those basic statements with which it is inconsistent (or which it rules out, or prohibits): we call this the class of the *potential falsifiers* of the theory; and secondly, the class of those basic statements which it does not contradict (or which it permits)"[13].

In other words, Popper holds, a falsifiable theory is such that the class of its *potential falsifier* is not empty. So the non-analytic scientific statements are those which would be refutable or falsifiable by some basic statements which Popper designs as 'any conceivable singular statement of fact'.

Popper however admits that the criterion of demarcation between sciences and metaphysics cannot work very sharply. He holds that the criterion " cannot be an absolutely sharp one but will itself have degrees. There will be well-testable theories, hardly testable theories, and non-testable theories those may be described metaphysical "[14].

Without going into detail we may note that this principle of 'falsifiability' seems to be a way of demarcating a theoretical sentence and an observational sentence. But according to Popper himself this demarcating line is not very sharp when applied to distinguishing 'scientific theories' and 'theoretical systems' or 'metaphysical theories', because the former embodies some 'speculative ideas of a non-empirical kind' and the latter have a close baering on the 'theories of science'. For example, *'the corpuscular theory of light'* or *'atomism'* or *'field theory of electricity'* are by themselves non-testable but they have an important relation to empirical science. Popper holds that in a scientific theory there may be 'metaphysical' (which have been referred to as 'theoretical' also by the philosophers of science) sentences as perfectly admissible components working as legitimate blocks. We may recall Hempel here as he also holds that in the 'vocabulary of science' there are theoretical terms which do not refer directly to observable entities.

In all these characterisations it is found that the theoretical sentences are held to be significant. They have been classified as 'metaphysical' and their distinct non-empirical character along with a close connection with observational sentences has been pointed out clearly.

The theoretical sentences, which should be taken only as constituents of a particular theoretical system, contribute to the cause of sciences. The theoretical systems comprise a metaphysical theory, a sort of overall world view, which in its turn directs and guides scientific investigations in many important ways. For this reason a theoretical system or a particular metaphysical theory may be described as the '*research programme*'. A research programme in this sense, however, may not be adequate always, as the conceptual framework prescribed in it may not explain the world of experience satisfactorily. In such a case, a new theoretical system giving a new research programme may be adopted.

Before we come to the point how a new theoretical system is adopted, let us discuss in brief, how scientists are committed to a particular metaphysical theory or a theoretical system. A theoretical system gives a sort of criterion for choosing the problem to be investigated and the sort of solution to be sought. The particular community of scientists which is guided by this theoretical system or metaphysical theory would thereby undertake some specific problems mainly for consideration — whereas others would be set aside as matters of no concern or as too problematic and not worthy of investigation. The pattern of thought to be taken up is displayed in the theoretical system explicitly or implicitly. Thus the theoretical language adopted by the Newtonian scientists would point out some different problems for investigation rather than those taken up by scientists of another discipline. This explains the historical fact that the scientists concentrate on some particular problems only for a long time, though a number of actual problems are there. What happens is that the metaphysical doctrine dominating the mind of the scientists at a particular age raises a number of problems and co-ordinates the various interests in the mind of the scientists. Thus the phenomenon of *diffusion* is full of instances in physical nature. Yet it was not given much attention before the eighteenth

century. It came to be regarded as important only when Maxwell included it in his study of physics. Here the change in the theoretical concepts brought a change in the scientific investigation.

Similarly, the conceptual framework embodied in each theoretical language has some explicit or implicit indications limiting the nature of solutions that are acceptable and the steps by which they would be explained. The apparatus to be used in the course of investigations would also be designed according to the metaphysical theory that is adopted. Thus an instrument which only attributes particular numbers to particular spectral lines would be satisfactory only if it can be analysed in terms of the *optical theory* and the numbers produced by it are shown to be included in the theory of *wave length*. Otherwise the apparatus has to be redesigned so that the experimental results are univocally correlated with the theoretical language or the metaphysical theory. Also, methodologically, the ultimate laws and the explanations would have some restrictions. Thus, some scientists would specify *corpuscular motion of interaction* and their explanations would reduce all given natural phenomenan to corpuscular action under some laws. The theoretical language adopted also indicates how the observation and experiments are to be correlated, so that the course of investigation proceeds systematically towards the goal.

Scientists are also committed to their theoretical language from an ontological point of view. Thus, if the metaphysical theory of one theoretical language tries to explain the universe in terms of only shaped matter in motion, then the scientists would assert the existence of only shaped matter that is in motion and would reject the possibility of existence of other entities in motion[15].

Maxwell in his paper ' The ontological status of theoretical entities '[16] has argued about the possibility of the existence of theoretical entities assumed in successful theoretical systems. He opposes the idea of taking the theoretical terms as merely instrumental of calculating devices. He argues " Today there is almost (not quite) universal agreement that not all theoretical terms can be eliminated by explicitly defining them in terms of observational terms. It seems to have been overlooked that even

if this could be accomplished it would not necessarily avoid reference to unobservables (Theoretical entities)"[17]. Thus, the elementary *kinetic theory* of gases could define ' molecules ' as ' particles of matter (or stuff) not large enough to be seen even with a microscope, which are in rapid motion, frequently colliding with each other and are the constituent of all gases '. Here all the non-logical terms in the definiens are observable, but the definition and the *kinetic theory* imply that the molecules are unobservable. Similar is the case with many theoretical terms like 'electro-magnetic field', 'function' etc. In all such definitions in fact, theories containing theoretical terms are used. It may be logically possible to obtain observational sentences without using intermediary theories, but then, the qusestions remain about the theories having theoretical terms which serve the purpose of the scientists very well. According to Maxwell, the success of these theories is due to the fact that ' well confirmed theories are conjunctions of well confirmed, genunine statements and that the entities to which they refer, in all probability, exist '. He goes further and argues that such theories are ' psychologically possible ' to invent because many of the entities to which they refer, resemble in many respects (although they may differ radically from them in others) the entities which we have already observed. Maxwell says that the pure sciences are all concerned with most observational data or predictions solely for their roles in confirming theoretical principles. This emphasises the importance of theoretical concepts. The theoretical entities are real, since, today, there are many theories which are ' well confirmed enough to argue strongly for the reality of such entities'. Also, they are satisfactory as they provide explanation of the observational events which they predict.

Thus, metaphysical theories or theoretical systems which are conjunctions of theoretical sentences are immensely important for sciences. But the difficulty lies in choosing one of the theories amongst all rivals. Metaphysicians in different ages have given different criteria for choosing a true theory. We shall however, take modern views in this regard.

It may be held that if the theoretical sentences could be connected to or explicitly defined in terms of observation-language, then theoretical sentences would be acceptable. We have

seen the difficulties of such definitions. Many theoretical terms cannot be defined explicitly and those definitions which seem to be explicit, actually cannot avoid reference to the theories. Again, there is also difficulty about observational language, which is neutral and independent of metaphysical theories according to those philosophers who advocate the ' rule of correspondence ' as a criterion for choosing a metaphysical theory. The impossibility and impracticability of such an observation language has been discussed by many philosophers.

We may take up another criterion of choosing a system as a whole. A theoretical system as a whole may be judged through the sciences following it. Thus, a metaphysical theory presupposed by some particular science, would be falsified if a hypothesis of this science is found false by some observational test. Again the metaphysical theory would be confirmed if the hypothesis is confirmed. In the latter case the said metaphysical theory would be held as accepted and so would hold ground until such tests are found which would falsify the scientific hypothesis. Here the metaphysical theory would not be directly confirmable or verifiable. We may refer to it as 'the indirect' way of testing a metaphysical theory.

This way of testing a metaphysical theory is, however, ultimately based on the Popperian way of distinguishing metaphysical theory from the sciences. According to Popper, the metaphysical theories are themselves non-falsifiable and yet the scientific systems which are falsifiable in principle are ultimately dependent on the metaphysical statements. This characteristic of metaphysical systems seems to have been pointed out by Popper when he refers to metaphysical systems as 'naturally arguable and criticisable.'[18] The metaphysical theories can be made 'criticisable' in this indirect way through their corresponding sciences.

In this way of testing, a falsifying test, which fails to be explained and accommodated by the prevailing metaphysical theory, would call for a change in the so far accepted metaphysical theory since this particular test has another conceptual framework at its background. Kuhn has referred to such a case as a revolution in the field of the sciences.[19] The new metaphysical theory would again have different sets of experiments and tests to confirm it.

Some thinkers have suggested that a crucial experiment should be built up for testing a particular science and the metaphysics behind it. But the phrase 'crucial experiment' is not much favoured by scientists. Also, for every science a crucial experiment may not be found.

We may, therefore, take the help of experiments only for testing a science along with the metaphysics behind it. But then a falsifying test may always come up which cannot be explained and accommodated by the prevailing metaphysical theory. Therefore, it seems, a metaphysical theory or theoretical system cannot claim absolute certainty and necessity. We can only suggest an indirect way of deciding about a metaphysical theory by saying that until an instance falsifying the science based on a particular metaphysical theory is found, that metaphysical theory would remain accepted. When such an instance comes up, however, both of them would fall together.

Delhi University,
Delhi—110 007.

Tripti Kana Sarkar

NOTES

1. The Theoricians' dilemma in 'Aspects of Scientific Explanation' Free Press, London, 1965. Hempel has admitted that this law has certain limitations and invites some improvement.
2. We may cite the name of Karl Popper who suggested to call the sentences containing these forms 'metaphysical'.
3. Suggested by Braithwaite in 'Scientific Explanations' Harper and Brothers, New York — 1960.
4. Op. Cit. p. 77.
5. Aspects of scientific explanation pp. 23—24. The Free Press, New York, 1965.
6. Philosophical foundation of Physics— p. 238. Basic Books Inc. Publishers, New York.
7. I have followed Carnap's explanation in 'Philosophical Foundation of Physics' — pp. 238—39.
8. We may refer to W. Kneale's view : 'Probability and Induction' Oxford University Press, London 1949.

9. "Logical structure of the World and Pseudo - Problems in Philosophy" translated by R. A. George; Routledge and Kegan Paul, London — 1967.

10. 'Semantics and Philosophy of Language'. Ed. L. Linsky, Urbana, Illinois, University of Illinois Press.

11. The logic of scientific discovery — K. Popper , Science Editions, New York — 1961.

12. We may note that Popper's use of the word 'scientific' seems to mean 'empirical character of scientific statements', since scientific statements must have other qualifications besides 'falsifiability'.

13. Op. Cit. p. 40 footnote 3.

14. Article 'Demarcation between Science and Metaphysics' in 'Conjectures and Refutations' — p. 257. Routledge and Kegan Paul, London, 1963.

15. A detailed discussion has been taken up by T. Kuhn in 'Foundations of Unity of Science' Vol. II, No. 2, University of Chicago Press, Chicago.

16. Scientific explanation, space and time, Minnesota 'Studies in the Philosophy of Science,' Vol. III, University of Minnesota Press, Minneapolis — 1966.

17. Op. Cit. p. 15.

18. The logic of scientific discovery, p. 206.

19. The structure of scientific revolution. Foundation of the Unity of Science, Vol. II, No. 2, University of Chicago Press, 1952.