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852ND ORDINARY GENERAL MEETING

HELD IN ROOM 19, LIVINGSTONE HOUSE, BROADWAY, S.W.1, ON MONDAY, MAY 3RD, 1943, AT 6 P.M.

DR. F. T. FARMER IN THE CHAIR.

The Minutes of the previous Meeting were read, confirmed and signed.

The CHAIRMAN then called upon Dr. Arnold S. Aldis to read his paper entitled "A Review of the New Scientific Outlook" (being the Dr. A. T. Schofield Memorial Paper for 1943).

The meeting was later thrown open to discussion, in which Mr. Leslie, Dr. Richmond Wheeler, Mr. McGavin and Mr. Ford took part.

Written communications were received from the Rev. Principal Curr and Mr. Belyavin.

The following elections have been made:—Paul Belyavin, Esq., Member; G. J. Herring, Esq., Associate; J. A. Silk, Esq., Associate.

REVIEW OF THE NEW SCIENTIFIC OUTLOOK.

By ARNOLD S. ALDIS, Esq., B.S., M.B., B.Sc., F.R.C.S.

(*Chairman: F. T. Farmer, Esq., B.Sc., Ph.D.*)

IN an age in which scientific progress is so rapid that the interested onlooker is apt to be left far behind, and the theories of the moment are quickly outmoded by some new advance, the word "New" which appears in the title of this paper requires some definition. Fortunately for the writer the important scientific discoveries which have led to the most remarkable revolution in scientific thought since the days of Newton have, almost without exception, taken place during the twentieth century, which therefore serves as a convenient criterion of modernity.

19TH CENTURY MATERIALISM.

The nineteenth century closed with the scientific scene dominated by a materialistic philosophy and a "world view" which was compassed by the rigid boundaries of mechanistic determinism. The scientific outlook was characterised by an overweening optimism, and the twentieth century was ushered in with a supreme confidence that, though science was not yet able to supply the answer to the riddle of the universe, this answer could not long be delayed. This attitude of mind was largely the result of the striking progress which had been made in the study of the life sciences following the publication of "The Origin of Species" by Charles Darwin in 1859. Up till that time, although the inanimate world was conceived of as being bound by the rigidly deterministic mechanics of Newton,

yet it was felt that the world of life introduced unpredictable and capricious elements which could not be included in such a closed system. With the introduction of the "Theory of Evolution" by Darwin, and more particularly following the contributions of T. H. Huxley and Haekel, it appeared that life itself was losing its mystery and that the simple hypothesis of natural selection was able to explain the vagaries observable in nature without recourse to any idea of a Creator. At the same time certain aspects of physiology and some of the schools of psychology were apparently suggesting that the idealistic dualism of mind and matter was illusory and that mind itself was only a function of matter so that materialism was able apparently to engulf its own antithesis mentalism, leaving the field clear for the undisputed sway of the materialistic "world view."

The New Physics.

Signs were not lacking, however, that such a rosy and hopeful outlook was built on insecure foundations, and already there were disturbing facts which obstinately refused to fit in with the accepted theories. It was known for example that Newtonian mechanics failed accurately to predict the motion and orbit of the planet Mercury, and several expedients had been formulated to account for the discrepancy. The classical experiment of Michelson and Morley was performed in 1887, and the disconcerting result which was to lead to such a revolution in thought was already known; but, generally speaking, scientists either closed their eyes to such discordant facts in what was regarded as the perfect harmony of science, or sought for some means of explaining the awkward facts in terms of the accepted mechanics. However, all scientific minds were not closed to the implications of these and other facts, as was shown by the publication of Planck's Quantum Theory in 1901 and Einstein's Special Theory of Relativity in 1905. This was followed by the General Theory of Relativity in 1915, and the Quantum Theory was advanced by the publication of the Principle of Uncertainty by Heisenberg in 1927, and by the wave mechanics of Schrödinger. It may be said that during the whole of the twentieth century thus far, scientists have been engaged in trying to readjust their outlook to fit in with the revolutionary conceptions which these theories introduced, undermining as they did the apparently solid foundations of Newtonian mechanics. Many it must be confessed have as yet failed to adjust

their thinking to these advances, as can easily be seen in much of the contemporary writing which is based on the deterministic materialism of the nineteenth century. One important reason for this failure on the part of some to keep step with progress in thought is to be found, I think, in the fact that although the Newtonian mechanics has been shown to be inadequate to explain the universe, yet it can still be applied with sufficient accuracy to things in the "man-sized" world which is the concern of the great majority of scientists. The new physics only becomes important in the realm of the astronomically large or the infinitely small, the discrepancies either cancelling out or being unobservable in the ordinary measurements of science in the "man-sized" world. This point is excellently illustrated by the story of the discovery of isotopes. The conception of the constant immutability of atoms as forming the fundamental bricks of the universe was severely shaken when Aston demonstrated that chlorine exists in two forms with atomic weights of 35 and 37, and when this discovery was extended to many other elements, doubt began to be cast upon Rutherford's accurate determinations of atomic weights and upon many calculations carried out constantly by chemists based upon these determinations. It was soon pointed out, however, that although undoubtedly many of the elements existed as a series of isotopes of different atomic weights, yet as far as could be ascertained the series as occurring in nature was a constant one. Therefore, in any chemical reaction involving many millions of atoms, the old accepted atomic weight, which was an average value based on the constancy of the mixture, could be used with perfect propriety. As soon as this was realised, the occurrence of isotopes ceased to worry the practical chemist since it did not influence or alter his everyday calculations, and it has since been mainly the preoccupation of a few research workers in the field of pure as opposed to applied chemistry.

Science and Philosophy.

When, however, scientists attempt to formulate a philosophy or "world view" based on the findings of science, these recent advances in scientific thought must be taken into account. An approximation, however close, is not a reliable signpost in the search for reality. It may be said that the scientists of the nineteenth century were generally speaking not greatly interested in the great metaphysical and philosophical questions of

"Being" and "Knowing." They were content for the most part to explore the physical universe using the empirical methods of science in an attempt to discover facts, without much concern as to whether such facts when discovered would fit into a rational picture of the universe. Many indeed went further and denied that the universe was rational or that there was any meaning to be sought in "existence." With the advent of the new physics, however, the scientists have once again entered the lists as protagonists in the great questions of philosophy, bringing with them the empirical methods of science by way of weapons. Nineteenth century scientists were so obsessed with attempting to answer the question "how" that they either ignored the question "why" or denied that such a question existed. The twentieth century discoveries have shown that such dogmatism is unjustified, and by defining the limitations of the empirical method they have brought the great question "why" back into its rightful place. It will be our purpose now to outline the scientific advances which have wrought this significant change in outlook, whereby scientists have been forced to forsake their old dogmatism, and to admit that there are questions to which science alone can never give any answer but that of reverent agnosticism.

Epistemology.*

In reviewing the development of the modern theories of Relativity and the Quantum theory of matter and radiation the first conclusion which seems to emerge quite clearly is that science can give us no information about ultimate Reality for two clearly defined though related reasons. In the first place the universe does not provide an absolute standard within itself upon which to base our scientific measurements. There is no yardstick with which to measure Reality in the physical universe, or at any rate not one which is available for our use. The theory of Relativity has demonstrated that all the measurements we make of space and time, and also of mass and velocity, are relative, and although they are doubtless related to some absolute standard, that standard is not discoverable within the physical universe by the methods of scientific observation for the simple but sufficient reason that we as observers are within the system and, therefore, we are strictly unable to adopt the detached observer attitude towards the universe.

* The theory of the methods or grounds of knowledge.

The Quantum theory has introduced another limitation to the scope of scientific enquiry in Heisenberg's Principle of Uncertainty which states that we cannot know with complete accuracy both the position and the velocity of a particle of electronic size at any instant, and still less can we predict either the position or velocity at any future time. This limitation to scientific method is a necessary outcome of the discovery which forms the basis of the Quantum theory, that radiant energy is not emitted continuously, but is given off in discrete packets or quanta which form the irreducible minimum of radiant energy. Now the emission of a quantum of radiant energy from any object imparts to the object a definite though almost infinitely small recoil in the same sort of way that a shell leaving the barrel of a gun imparts a recoil to the gun. In the ordinary " man-sized " world even the cumulative effect of the impact of millions of quanta does not have any appreciable effect upon the object because of the almost infinite disparity between the inertia of the quantum and of the object. The position, however, in the subatomic world is quite different, for in this world of the almost infinitely small the emission of a quantum of radiant energy is such a world-shaking event that the atom is virtually a different object to that which existed before the emission of the quantum. As the emission of a single quantum is in the nature of things, the most delicate instrument at the disposal of scientific observers, it must be clear that the scientific method will never be able to probe further into the ultimate nature of Reality. We can never know what an atom is like unless it emits quanta of energy which are our only means of observation, and the emission of a quantum at once alters the thing we are trying to observe; this is the impasse to which the Quantum theory has brought us. The " observer-object relationship " which is the foundation of the scientific method depends for its validity entirely upon the assumption that it is possible to adopt the observer attitude towards physical objects without altering the objects by the mere act of observing them. It is now clear that this assumption is not permissible when we come to the ultimate structure of the material universe, and we see that the " observer-object relationship " is invalid in the astronomical sized universe because there is within it no fixed observer viewpoint which we can take up, and in the subatomic world because here the very act of observing alters the thing which we are trying to observe.

Presumably the same limitations apply to the "man-sized" world, but here they are of little practical importance for reasons which we have discussed; so that we find that the astronomers and physicists have been quick to appreciate the implications of the new physics, while the general run of scientists whose preoccupation is with the "man-sized" world have paid but scant attention to theories which seem for them to have very little practical significance.

The reader will have observed that the foregoing arguments have a profound bearing upon Epistemology, and set clear and definite limits to the usefulness of the scientific method as a source of knowledge. Sir James Jeans expresses it thus:—"The true object of scientific study can never be the realities of nature, but only our own observations on nature." The only legitimate attitude for the true scientist to take up is that of the Phenominalist who recognises that his observations do not constitute a knowledge of Reality, but only of the appearance of Reality as seen in the distorting mirror of scientific Epistemology. The scientist, therefore, who takes it upon himself to make dogmatic statements concerning the nature of Reality based entirely upon his scientific observations, steps outside his legitimate province, and his pronouncements have neither scientific nor philosophical authority. There can, therefore, strictly be no ground for controversy for example between Science and Religion, for the scientist's method can neither prove nor disprove religious beliefs which are concerned with the ultimate realities of the universe. If we believe with St. Paul that Faith is the evidence of things unseen it is at least certain that science can never prove us to be wrong, for the very fact that the Eternal things are unseen, and indeed unseeable, places them forever outside the scope of scientific enquiry.

Reality—Material or Mental?

Although, as has been shown, science can never give us any final information about Reality, nevertheless the new Physics does give us some hint concerning the direction in which Reality lies, and the present position of science in this respect is far more in favour of the Idealist than the Realist philosophy. The signposts, such as they are, seem to point towards mentalism and away from materialism. This may perhaps be made clearer if we note the significant fact that the recent advances in the

interpretation of the universe have been made possible by the application of pure mathematics. Einstein's theory of Relativity can really only be expressed in a series of mathematical equations, and it is impossible to make or imagine a mechanical model of such ideas as the "space time contimum." At the other end of the scale, the Quantum theory has led on to the intensely mathematical wave mechanics of Schrödinger. Thus the more scientists have sought to probe the ultimate mysteries of nature, the more they are driven to formulating their discoveries in terms of pure mathematics and away from the pictorial or mechanical model. Now, while we should be wrong as we have shown to suppose that such mathematical equations represent Reality, yet it is at least suggestive that there must be in Reality something of the nature of pure mathematics, which is essentially a mental construct. Thus we are led to the position that the Reality which lies beyond our observations would seem to partake of the nature of mind rather than of matter. Thus Eddington says: *"We reach then the position of the idealist as opposed to the materialist, philosophy. The purely objective world is the spiritual world; and the material world is subjective in the sense of selective subjectivism." While Jeans put it in these words: †"Thus the relativity theory of gravitation, because of its close association with pure mathematics, seems to carry us yet further along the road from materialism to mentalism, and the same may be said of most of the recent developments of physical science."

The new Physics at least suggests that the ultimate reality behind the physical universe is akin to mind, and the Theist will identify this with God, while other philosophers will recognise in it the universal or cosmic mind, a phrase which has been used again recently by Professor Wood Jones. The Biblical Theist will find all this very much in accord with the world view expressed in the Epistle to the Hebrews, where God is represented as "Upholding all things by the word of His power."

Determinism or Freewill?

The new Physics also has some bearing upon the age-old philosophical problem of human freewill. The classical mechanics was rigidly deterministic and seemed to prove that freewill was illusory. This belief which was characteristic of the nine-

* Sir Arthur Eddington—The Philosophy of Physical Science.
† Sir James Jeans—Physics and Philosophy.

teenth century was strengthened by the teachings of the Behaviourist school of Psychology. The Quantum theory has, however, struck a severe if not mortal blow at closed determinism, as it shows that the ultimate processes of nature are not deterministic; or, if they are, science cannot discover what it is that determines them. Heisenberg's Uncertainty Principle, which has already been mentioned, shows how unpredictable are the events in the subatomic world; and indeed in this world the ordinary ideas of causality cease to have any meaning.

At the risk of tedium I must reiterate that Heisenberg's Uncertainty Principle which dominates the picture in the subatomic world must also apply theoretically to the "man-sized" world, although in practice the cumulative uncertainties tend to cancel out so that the underlying indeterminacy of nature is obscured by an artificial determinism. We thus arrive at the rather surprising conclusion that the law of chance must be one of the fundamental laws of the physical universe, so that all scientific predictions are predictions of probability and not of certainty. A familiar illustration comes to mind in this connection. If a coin is tossed once there is an equal chance of its coming down heads or tails; the result is quite unpredictable. If the coin is tossed 500 times, however, we shall not be far wrong if we predict that it will fall heads 250 times and tails an equal number; and the greater the number of times the experiment is repeated the closer will our prediction, based on the law of chance, approximate to the experimental results; in other words, the more and more deterministic the experiment becomes. Thus the basic law is the principle of uncertainty, and the law of chance only becomes deterministic when dealing with large numbers. It is at once clear that such determinism is in a sense artificial, and is certainly not rigid for it is easy to envisage circumstances in which it might be overruled. To return to the illustration, it would be perfectly possible to devise a machine to do the coin tossing with such precision that the result of the experiment could be altered in any desired way, so that in 500 spins of the coin it would fall heads 500 times or any other combination.

This, it seems to me, gives us just a hint of the way in which human freewill could operate upon the substract of subatomic indeterminacy by causing the cumulative indeterminacies to add up in the desired direction rather than cancelling out, so that they would become operative in the "man-sized" world. Again an illustration comes to mind. An iron bar if isolated

from a magnetic field does not show magnetic properties, and it is generally supposed that this is due to the haphazard arrangements of the groups of atoms within the bar. If it is placed in a magnetic field, however, the atoms become orientated in such a manner that the inherent magnetic qualities of each group become cumulative and act in the same direction so that the iron bar now exhibits the properties of a magnet with a North and South Pole.

The writer is well aware that the foregoing arguments do not form in any sense a scientific proof of the reality of freewill. Indeed, it would belie the main contention of this paper if they were advanced as such, for clearly the question of human freewill comes into the category of non-material Reality in which we have insisted that science has no authority to speak. We cannot invoke the aid of science to prove any subject in which it can be shown that science can supply no valid or reliable data. The arguments have been advanced not so much to prove a doctrine but as an attempt towards supplying an acceptable account in scientific terms of the mechanism of a doctrine which is accepted as a fact of experience. All that modern science can really say on the subject of freewill is that modern science cannot disprove its reality. The classical physics envisaged a world which was rigidly determined by the physical law of cause and effect, in which it was assumed that a physical "effect" must, and could only, be determined by a physical "cause." The discoveries of modern science have not upheld this belief, for they have shown that there are undoubted physical "effects" in the universe for which science can point to no physical "cause," as for example in the breakdown of radioactive elements, which does not seem to be determined in the old accepted sense. It is this breakdown of the final validity of the physical law of cause and effect with the resulting possibility that physical "effects" may be produced by non material causes, which has opened the door again to the possibility of freewill.

To quote again from Sir James Jeans :—

> *3. "The classical physics seemed to bolt and bar the door leading to any sort of freedom of the will; the new physics hardly does this, it almost seems to suggest that the door may be unlocked—if only we could find the handle. The old physics showed us a universe which looked more

* Sir James Jeans—Physics and Philosophy.

like a prison thas a dwelling place. The new physics shows us a universe which looks as though it might conceivably form a suitable pwelling place for free men and not a mere shelter for brutes."

Conclusion.

To recapitulate ; it would seem, broadly speaking, that the new physics demonstrates conclusively that the scientific method as an instrument of Epistemology is necessarily too coarse to give us any information about Reality as sought by Metaphysics. At the same time it gives us the hint that if such Reality could be found it would be in the nature of mind rather than of matter, and it paints for us a picture of the universe in which the sombre colours of materialistic determinism are lightened by the dawning possibility of some sort of freewill.

It must not be supposed that the conclusions which I have sought to present are universally accepted by the scientific world ; indeed, there are not a few dissentient voices. Curiously enough these are mostly to be found among the ranks of the Biologists. The life sciences which were the last to yield to the sway of nineteenth century materialism, seem to be the most loath to relinquish it. They exert an influence upon public opinion which is out of proportion to their numerical strength, for their writings which are numerous have been widely publicised. These men almost with one voice preach a doctrine of scientific humanism, in which science is made the basis of ethics and the formula for social progress, and their position has been well set out in a recent symposium under the title of " Science and Ethics " in the columns of " Nature."

It will be sufficient here to remark that they must be content to be caught in the toils of the rigidly deterministic science which they preach. If they elect to cling to a materialistic conception of the universe governed by inexorable laws of rigid determinism, then it is futile for them to attempt to alter or determine the course of social evolution, for the freewill which they invoke to do so has no place in the world view which they have espoused. It is to be hoped that the encroachment of chemistry, and more recently physics, upon the life sciences in the relatively new sciences of biochemistry and biophysics will make this attitude less and less tenable.

Those of us who, like James Ward, regard the universe as a realm of ends, may be assured at least that true science has

nothing to say to the contrary. If there be a Divine purpose behind the universe, it is not within the province of science either to discover it or to deny it. The Christian as a new creature is given in Faith a source of knowledge of Reality which is denied to the materialist, but the validity of which the materialist has no right to deny—a new sense which responds to the stimulus of Divine Revelation as the eye to quanta of light or the ear to waves of sound. James Ward, in the conclusion of his Gifford lectures, discussing Nietzsche's idea of an Uebermensch, expresses this view in words which will serve well to bring this paper to its conclusion :—

> *"The regenerate Christian is already an Uebermensch, no longer natural man, but spiritual in the Pauline sense, nor is his experience fairly described as subjective belief in God ; it is actual love of God and conscious communion with Him. We have no right to question this, though we must admit that such inward convictions of the reality of religious experiences are, for the purposes of our discussion to be classed as Faith, not as knowledge, in as far as it is, —epistemologically, though not psychologically—subjective, incommunicable and objectively unverifiable. In so far, however, as he lets his light shine and men see his good works, the religious man affords practical evidence of the worth of his faith. With enough of such light, the justification of Faith would be sure."

Discussion.

The Chairman (Dr. F. T. Farmer) said : It has been a pleasure to listen to Mr. Aldis' paper, and I am sure you will all wish to join me in thanking him very heartily for it. The subject which he has reviewed is one which is full of intricacies and difficulties, and it is to his great credit, in my opinion, that he has presented it so lucidly that we can all understand and appreciate the essential points without getting lost in a mass of detail. It takes a scientist to understand the problems of modern physics, but it takes more than a scientist to see beyond the physics into the ultimate significance of it all.

I am one of those who believe that a chairman's remarks should be brief—very brief. And I know there are plenty of people wishing

* James Ward. Gifford Lectures. Realm of Ends.

to express their opinions on this interesting subject, so I do not propose to say more than a few words. Those words will be of a rather general character.

Until recently science was concerned only with inanimate physical systems, matter, heat, energy, and so on. From these it has spread with great rapidity to cover almost every field of enquiry, and it is commonly held now that science is concerned with the *whole of life.* Every problem is to be considered in a scientific way, even in psychology, sociology, ethics, politics and religion. By tackling them objectively, scientifically, it is claimed, they can be solved just as material problems. Up to a point this attitude has been valuable and fruitful, and has served to get behind emotions and prejudices which are the great barrier to accurate thinking. It has probably marked a step forward in every field in which it has been applied. But it has a danger, I think, and this danger should not be overlooked. There is a tendency to elevate the scientific attitude almost to the level of a god, and to suppose that it rules the whole of the universe, in fact, that it contains the key to moral as well as material problems. Man's salvation is to be by science, no longer by the Cross of Jesus Christ. In other words, it is assumed that science is able to distinguish between right and wrong, and to say that this thing is good, and that thing is bad.

Can this be so ? I think the answer is quite definitely, No. The scientific method is one that relates cause and effect. It says that if we know everything about a system at time t_1, then we can deduce its entire state at some future time t_2. But it can never say what it *ought* to be like in the first place ; the word has no meaning in a scientific sense.

That is the position as I see it. The old determinism of the 19th century has gone. But in its place a more subtle form of materialism has arisen, and it is one that presents at least as great a challenge to Christianity. The scientific outlook has become not only the sufficient basis for all human needs and the sufficient answer to all human problems, but also that which if necessary man may worship as the supreme power.

Mr. J. S. C. McGavin said : I fear that materialists will take up the statement on page 79 that a result of coin-tossing is " quite

unpredictable." They will say, and rightly, that as all the factors involved can be known then the result can certainly be predicted. The author's statement is no doubt sufficiently exact for most practical purposes, but in a matter which is so controversial we cannot be too exact in our statements.

Though science and religion may normally till different fields, yet in the last analysis, as Truth is one, they must come to some terms. Mysticism, purporting to be entirely independent of historical facts, may be able completely to ignore anything that science may say. Christianity, on the other hand, is based on historic events and stands or falls with them. From this point of view Christianity must take note of the voice of science.

In connection with the " observer-object relationship " mentioned on page 76, it is helpful to remember Professor Lamont's* distinctions between " I—my world," " I—Thou," and " I—Absolute." These are dimensions differing in quality. Science normally is only concerned with the first of them.

Gp.-Capt. WISEMAN said: Dr. Aldis has given us an admirable summary of some of the more recent trends of scientific thought. It is quite apparent that whereas at the beginning of this century the general attitude of scientists was that of Parmenides, " Nothing flows, all things remain," the prevailing attitude at present is that of Heraclitus, who said, " All things flow, nothing remains."

More recently, men of science are aware of a sense of limitation, even of frustration. Earlier in the century it was assumed that all things could be measured or calculated with absolute accuracy. In the realm of astronomy Einstein revealed limitations, and in physics, Heisenberg and Dirac explained why there was little or no hope of measuring the real behaviour of electrons or similar particles. The writings of scientists reveal a growing sense of something mysterious which lies beyond mathematical calculations.

Dr. RICHMOND WHEELER suggested that the value of papers read before the V.I., such as the one they had just listened to, would be enhanced if references included date of publication, publisher's name, and page.

* Lamont, " Christ and the World of Thought," 1935, p. 62f. Publishers T. & T. Clark.

He considered that the influence of biochemistry and biophysics at present was definitely materialistic. A better way seemed to be that of Dr. J. Gray, who urged that biology should be the mistress in her own studies of living matter (*Adv. of Sci.*, 1933, p. 92). Animals were conscious wholes, partly independent of their physical environment, as Dr. E. S. Russell and other naturalists showed; this outlook was supported by the incontrovertible facts of biogenesis. Human free-will got definite scientific support from the recognition of the autonomy and non-material nature of Mind, as Jung, McDougall, Brown, Stout and other leading psychologists taught (cf. Wheeler, *Vitalism*, Allen & Unwin, 1939, 176-91). Special creation of animal consciousness and the human spirit had been maintained by A. R. Wallace against nineteenth century materialism.

Written Communications.

Mr. Paul Belyavin wrote: I have read with considerable interest the paper presented by Mr. Aldis, and it appears to me to be a very clear and accurate presentation of the modern scientist's point of view.

After many years of study of various related problems, however, I now always endeavour to examine all, what we call "modern views," also in Time-perspective. To explain it more clearly; to-day we have heard the new scientific outlook, 1943. But in 300 B.C. the new scientific outlook was that of Aristotle.

What I would like to know *now* is—what will be the "new scientific outlook" in the year 3943? Can our present day science be considered final and immutable, or should it be considered only as a temporary expedient?

I think that scientists have actually committed their theories to a position of a temporary expedient by admitting that they are not interested in what things are but only in how they behave.

The actual reason for the adoption by the scientists of this idealistic and phenomenalistic attitude was the utter frustration of the ontological philosophy. The latter was brought about by the apparent realisation of the possibility, that there may be, after all, no objective Ultimate Reality, and, as some of the philosophers have put it, "the ever-rolling stream of changing phenomena may

be the only ultimate Reality." This view is as old as Protagoras and Heraclitus.

But there may be a different aspect of the problem—that the Ultimate Reality may have its beginning at the infinitely small, and continue its development following the same path and on the same principle through all scales of existence.

It is possible that Ultimate Reality may be found not in an irreducible particle of matter, but in a principle of organisation, in a system on which the Universe of Infinite Space is built.

We are legitimately justified in expecting the Universe to be built as a rational organisation, for we have undeniable evidence of such an organisation on Earth, which is one of the elements from which the Universe is constructed. It would be illogical and unrational for a Universe built from organised individual units like Earth, to be nothing more than an accidental Chaos. This principle, or system, is likely to extend also to the basic structure of matter.

Have we then any right or reason to expect that if and when the Ultimate Reality will eventually be discovered, it will not prove destructive to all existing scientific theories ?

The scientists say no, our theories are bound to endure for the very reason that they are built on observation, inference and scientific verification, and not on any fanciful and changeable ideas of Ultimate Reality. But are they ? To make this matter clear, let us examine critically the Atomic Theory, which is the foundation stone of modern science.

As we all undoubtedly know, the scientist alleges that all matter is made from atoms, which, in their crude original form, are assumed to be built from a nucleus consisting of protons, neutrons and electrons, with one or more electron revolving around it in orbits.

We can omit all further developments of the atomic theory which are irrelevant to our present task.

The revolving motion of electrons around the nucleus is necessary to counteract the attracting forces between electrons and the nucleus. But the question is, *why* should the electrons revolve around the nucleus, and *how can they ?* For there is no law in heaven or earth which would cause them to revolve, and the simple forces of attraction between the electrons and the nucleus cannot possibly give rise to any other forces which could cause revolving motion.

In fact, if this revolving motion were a possibility, then perpetual motion should also be possible and easy, which we know it is not. Consequently, this revolving motion could only be caused by supernatural intervention, a miracle. But is it right to build a scientific theory on the foundation of a miracle? For, as we can easily visualise, miracles make all sciences redundant and unnecessary.

Everything then can be explained by a miracle, so why should we bother about any sciences? But this is not all.

If all matter is made only from electricity, what are the electrons themselves made from? Is electricity matter, or is it not? If it is matter, why should we deny it atomic structure?

So you see, that we are really back to where we started from and the atomic theory may be, after all, just as bottomless as the problem of Ultimate Reality. Indeed, the scientists themselves admit now that after having added to it the Quantum theory, the Heisenberg's Principle of Indeterminacy and the Relativity theory, the modern physics can no longer be presented to the mind in terms of physical models but must be left in the form of mathematical equations.

The last statement is, to say the least of it, startling. We all know that a mathematical equation is only a certain form of presentation of some logical deduction, a concept. Hence, if we are told that such a concept may not be there, we are justified in expressing our doubts about the mathematical equation being properly understood by scientists themselves. It certainly appears that it is no longer the mind which dominates the formula, but it is the formula which dominates the mind.

The conclusion is, that we should not consider any modern theories as being something final and immutable, but only as a temporary expedient, to serve in the meantime some useful practical purpose.

Mr. E. H. BETTS wrote: We are indebted to Mr. Aldis for his succinct account of recent advances in mathematical physics and their philosophical implications.

We feel, however, that recent thought is too ready to accept unquestioningly anything offered by the mathematicians. The status of mathematics in mathematical physics has yet to be made clear. A few remarks must here suffice. They may be sufficient to indicate that the position is one which really needs clearing up.

First, no mathematical structure can have the least bearing on physical problems unless it starts from *sensa* or data given as the results of ordinary observation.

Secondly, no mathematical structure has any physical truth or validity unless it is not only based on observations in the physical world, but returns to that sphere with numerical values which can be tested against actual observations.

Thirdly, it is possible to build mathematical constructions based on unimaginable and deliberate absurdities (such, for example, as an index of optical refraction explicitly involving $\sqrt{-1}$), which constructions will give formulæ which fit the facts obtained by observation of nature and are in that sense true formulæ. It is, however, obviously not therefore legitimate to argue back from the validity of the formulæ to establish the physical reality of the admittedly absurd basic hypothesis. Such considerations must weaken an attitude of implicit confidence towards mathematics in its applications to physical problems. For, no less than in the above case of absurdity, we are asked by the mathematicians to forsake our common sense in accepting the space-time continuum and curved space, which Jeans himself admits to be unimaginable (New Background, p. 136), but which is held by Professor Castelnuovo *as an object of sensory perception*, to be an essential element in relativity theory (cited by W. R. Thompson, F.R.S., in *Science and Common Sense*, p. 91).

Fourthly, although the physico-mathematical Theory of Relativity tested by numerous actual measurements of varied types proves to be satisfactory and in this restricted sense "true," we have seen that mathematics is of such a nature that such "truth" does not at all argue the truth (in the sense of *physical reality*) of the basic hypothesis involved. For the hypothesis of the ether explains literally thousands of large-scale phenomena. "The representation chosen is so perfect that one is sure of calculating in advance, for example, any diffraction figure one requires, no matter how complex is the form of the holes pierced in a screen" (Bouasse, cited by Thompson, *loc. cit.*, p. 108). Nevertheless, the physical reality of the ether cannot be upheld. Our third observation, above, indicates that Einsteinian Relativity may have no better standing. It is not an explanation but a "description," in mathematical terms, of the "pattern of events."

Does it not behove us, then, to view with extreme caution any physical or philosophical conclusions drawn from such "descriptions." The mathematical physicists are themselves learning to be cautious. Jeans declares, as a conclusion to his latest book, "The plain fact is there are no conclusions." (*Physics and Philosophy*, p. 216). The suggested viewing of ultimate reality as mental rather than material, even as a mere suggestion, has little to back it.

Mr. W. E. LESLIE wrote: One of the most important points dealt with in this very excellent paper is the discussion of the bearing of the Uncertainty Principle upon the doctrine of Determinism. A difficulty that arises is the tendency of any argument which invalidates Determinism to undermine the principle of Causality also. The author seems to realize the difficulty, for on page 79 when he speaks of causality in the sub-atomic world he says that there "the ordinary ideas of causality cease to have any meaning." Does some special idea of causality still have meaning? The author does not tell us. But on the same page he speaks of the human will "*causing* the cumulative indeterminacies to add up in the desired direction. . . ."

In thinking of God we must use anthropomorphic terms—terms of the man-sized world. It may be that in the microcosm and the macrocosm we begin to pass out into ultimate realities which our minds as at present constituted cannot grasp.

At the end of the paper Faith is spoken of as though it were a new mysterious sense. But surely it is an activity of the intellect "he that cometh to God must believe that He is . . ." blended with an act of the emotions "thou shalt love the Lord Thy God . . ." and the will "to as many as received him. . . ."

Rev. Principal H. S. CURR wrote: Dr. Aldis's treatment of an abstruse subject is so lucid that even those, whose studies have not lain in that direction, may feel emboldened to make one or two comments. These must inevitably be of a very general and non-technical character. The justification for them may be found in the familiar truth that, while the man, who cannot claim to be

a specialist, may be incapable of understanding and appreciating the paths and processes whereby certain results are achieved, he is frequently competent to offer opinion on the conclusions, when these are finally stated.

One such observation is prompted by Dr. Aldis's reference to the relations of science and religion. He makes it clear that these are occupied with different departments of human experience which may thus roughly be designated. Science is concerned with the things which are seen and temporal, while the province of religion must be sought in the things which are unseen and eternal. But since truth, in the last analysis, is one, wholly self-consistent and indivisible, it must be a subject for rejoicing amongst religious people that scientific doctrine is flowing in channels which accord a great deal better with religion than those which were most prominent at the end of last century. Faith is thus made much easier to the modern mind, imbued with modern culture, whilst living, moving, and having its being in modern conditions.

I would venture to deprecate all attempts to resolve the material into the mental, or the mathematical. After all has been said, the use of mathematics to express the teaching of scientific research is merely descriptive, as Dr. Aldis explains. It would be a mistake to argue that, because a phenomenon cannot be imagined, it has, therefore, no objective reality. There are things in heaven and earth which the eye hath not seen, nor the ear heard, nor have they entered into the heart of man. But their independent existence is not in question. God reveals them to such as He pleases by His Spirit (1 Cors. ii, 9-10).

Physics and metaphysics alike search for some basic factor which will serve as a body of union and unity for all things else. Some have tried to find it in matter, and others in spirit. Materialism and idealism have both enchained the minds of men. Does the Bible not supply the clue by its affirmations that in Christ all things consist, as Paul demonstrates so powerfully in Colossians, 1, 9-20. In His Incarnation, mind and matter kiss each other. He is the Truth as well as the Way and the Life. It cannot be otherwise since personality is the highest and deepest category which we know. The ultimate cannot be anything less in any branch of human knowledge.

Mr. E. A. MOBBERLEY wrote : In addition to the books mentioned in the very lucid account of the above subject, as given by Dr. Aldis, the following contain interesting information :—

The *Revolution in Physics*, by Zimmer (1941). An outline of the older " classical " physics is given and it is shown how new theories have become necessary in order to elucidate experimental results. For instance (page 59), " We have before us two theories of light, each of which is able to explain only a part of what we know about the properties of light." The wave theory helps to explain diffraction and interference, but does not explain Millikan's experiments (page 61), which showed, in 1916, that a charged electroscope can be discharged by light and that the discharge depends on the energy of light particles (spoken of as " bullets," " darts," or " Photons "). The book also gives an account of the various theories concerning the nature of matter. The account is admittedly incomplete because unmathematical.

In *Physics and Philosophy* (1942) Sir J. Jeans says (page 133): " The wave-picture and the particle-picture do not show two different things, but two aspects of the same thing."

The World as I See It, by Einstein (1935). This book (not entirely in a scientific vein) gives some references. On pages 138, 139 and 156, is given the relation of the quantum theory to atomic structure. In speaking of theories concerning themselves *solely* with the *probability* of the occurrence of physical reality, he says (page 161), " I am still inclined to the view that physicists will not in the long run content themselves with that sort of indirect description of the real." In this paragraph and on page 159, " partial differential equations " are mentioned as the " natural expression of the primary realities of physics."

It seems to me that there is general agreement between the scientists mentioned that only *partial* explanations are given by the various theories—each being wonderfully adequate, *as far as it goes*, in giving mind pictures of *one* aspect of the properties of light and matter, but these things are really in themselves *unique*.

Towards a Christian Philosophy (1942). Professor Hodgson gives a profound study of some of the philosophical problems which are mentioned by scientific writers, but never really solved by the latter as they are outside the range of science. He says (page 172) that

" when we try to study the universe by scientific method, for a while it seems to respond encouragingly to our enquiries, but when we push these enquiries further in an attempt to grasp its fundamental nature, it seems to slip through our fingers and elude us. It is, I believe, true to say that so far as we are seeking to know enough about it to control it, it is responsive to us. It is when we seek to answer the question of what it is in itself that we are baffled."

Examples of this " control " are seen in the applied sciences, such as mechanical, electrical and civil engineering, metallurgy and chemistry, and—perhaps most important of all—medical science.