THE FREEDOM OF MAN

BY

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TO

MY FATHER

PHILOSOPHER AND FRIEND

who for many years has taught his students, myself among them, the way toward a rational and satisfying Christian philosophy, which he has found for himself by careful study, constructive imagination, and keen appreciation of the values of life.

PREFACE

In this little volume I have brought together the material which was presented as the Terry Foundation Lectures at Yale University in 1931, as the Elliott Lectures at Western Theological Seminary the same year, and, under the general title of "Man's Place in God's World," as the Loud Foundation Lectures at the University of Michigan in 1935. These lectureships have given me an opportunity for formulating for myself, much more carefully than I otherwise should have done, the relationships between my own scientific and religious thinking.

It is frequently imagined that in scientific writings one deals only with tested facts, and that though mistakes may of course be made, experimental observations make unnecessary the venturing of opinions or guesses. On the contrary, probably not even in art is the imagination applied as effectively as in science. It is by making many hypotheses and testing their consequences that all the important generalizations of science have been reached. It is rare indeed that the first formulations are found to be adequate. In fact, occasionally, hypotheses that have successfully withstood many tests and have led to important advances are found to be wholly false. As historic examples we may mention the Ptolemaic system of planetary motions, the phlogiston theory of combustion, and the elastic ether theory of the propagation of light. Nevertheless, each of these hypotheses encouraged experiments which in turn led to the attainment of a more adequate theory. Thus the man of science is inclined to take a pragmatic view of his own work. Neither theory nor experiment is considered to have much value unless it leads to something previously unknown. Our experiments are designed to test theories or to open up new fields of investigation. Our theories must either help us to correlate data that previously seemed unrelated, or must enable us to make valuable new predictions. Even though the theory may ultimately be shown unsound, if it points the way to valuable new information, it is useful and hence good.

Thus science approaches truth through a series of successive approximations. Even Newton, who, with the insight of genius, proposed a set of laws of motion and gravitation, thus accounting for phenomena previously thought mysterious, has his theories revised by Einstein and Heisenberg before they are adequate to meet the exacting needs of our later observations. Now in our studies of quantum electrodynamics we are attempting to refine even these modifications so as to account for our most recent experiments.

It is in much the same spirit, it seems to me, that the scientist must venture into such related fields as philosophy and religion. He knows that he will very probably make false steps. Yet unless he brings before the educated public those findings which appear to him significant, the philosopher and the theologian have no means of learning of those findings. If the scientist's amateur interpretations are found faulty, these faults and inadequacies can be remedied by those having a more extensive philosophical background. If, however, the scientist for fear of making such errors were to keep to himself his newly acquired knowledge, it would remain unavailable for the guidance of men's actions.

Some of my colleagues wonder how a man who is busily engaged in scientific research can afford the time to try to relate his findings to other fields of human interest. My answer is twofold. In the first place, as Eddington has so clearly shown in his *Nature of the Physical World*, science represents but one aspect of human experience. I find myself unsatisfied without at least a careful attempt to relate the various aspects of experience with each other in my own mind, thus formulating a philosophy which I can use for guiding my own life. In the second place, I consider it the scientist's clear duty to the society which makes possible his investigations to report his findings to that society in a form that can be understood, together with an effort to show their import in so far as they would seem to affect human life. He must in such presentations take extraordinary pains that the science which he reports shall be accurately stated, for that is where his listeners rely upon him as an authority. It is relatively unimportant if his interpretation of that science is inadequate or even wrong, for such deficiencies can be found and corrected by those more thoroughly versed in the related fields.

Science does not pretend to interpret all aspects of life. Yet few in this age would willingly base their lives on a philosophy which to the man of science is demonstrably false. Science thus takes the place of the foundation on which the structure of our lives must be built if we wish that structure to be stable. The architecture of the building which we erect must conform to this foundation; but great latitude remains in its design. That design, as Pythagoras saw thousands of years ago, can, however, be made more perfect if the form of the foundation is known.

In preparing these lectures I have been

strongly impressed by the way in which science can be interpreted to give a moral and ethical outlook closely parallel with that taught by the highest types of religion. The language and the mode of thought are different, but the correspondence between their conclusions is close. Far from being in conflict, science, as Dean Inge has remarked, has become an ally of religion. By increased knowledge of nature we become better acquainted with the God of nature, and with the part we have to play in his cosmic drama.

A.H.C

Oxford, May, 1935.

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I.

FREEDOM VERSUS LAW, AN AGE-LONG CONFLICT

Again, if motion is always one long chain, and new motion always arises out of the old in order invariable, and if the first beginnings do not make by swerving a beginning of motion such as to break the decrees of fate, that cause may not follow cause to infinity, whence comes this free will in living creatures all over the earth, whence, I say, is this will wrested from the fates by which we proceed whither pleasure leads each, swerving also our motions not at fixed times and places, but just where our mind has taken us? LUCRETIUS, *De Rerum Natura,* II, 251–260.

THE fundamental question of morality, a vital problem in religion, and a subject of active investigation in science: Is man a free agent?

If our actions are the necessary outcome of our past history, if the atoms of our bodies follow physical laws as immutable as the motions of the planets, why try? What difference can it make how great the effort if our actions are already determined by mechanical laws of cause and effect? Our purposes cannot then be effective. It becomes unreasonable to hold ourselves responsible for our actions, over which we have no control. What we call "initiative" becomes the work of a complex automatic machine. Morality has become a fiction. Life has lost all human meaning.

We may be led to see operating in the vast machine which we call the universe a supreme Intelligence, which we may call God. Yet men have become his toys, not his children, incapable of doing anything that they have not been made to do. Though men may enjoy the life that has been given them, they can have no part in shaping it. Any religion based upon such a relationship between man and his Creator can be no more than a pale shadow of a religion in which a man can say "my Father worketh hitherto, and I work."

Not only the physical and biological sciences, but to a large extent psychology as well, have made great strides in interpreting nature on the basis of mechanical laws involving cause and effect. The motions of planets, the flight of airplanes, the swing of pendulums, are nicely described in terms of well-established laws of motion. The explosion of gunpowder, the creation of a beautiful dye from black tar are explained by the mutual attraction of atoms. A man becomes insane because the colloids in his brain cells are precipitated by an alkaloid in the blood. Yet is it possible in terms of the motion of atoms to explain how men can invent an electric motor, or design and build a great cathedral? If such achievements represent anything more than the requirements of physical law, it means that science must investigate the additional controlling factors, whatever they may be, in order that the world of nature may be adequately understood. For a science which describes only the motions of inanimate things but fails to include the actions of living organisms cannot claim universality. If man's actions are not determined by physical law, it becomes a vital question for science to find whether his actions are determined, and, if so, by what factors.

Traditionally, the attitude of both religion and philosophy has been divided as to whether man is really responsible for his actions. Science has definitely affirmed the complete physical determination of man's actions, although most scientific men have assumed that they could act as if they were free. Judaism and Christianity have always firmly insisted on man's responsibility to God. "As for me and my house, we will serve the Lord," is a typical statement, implying complete freedom to obey or disobey as we may choose. Even here, however, as in the Calvinistic doctrine of predestination, we find an occasional strong tendency toward throwing all responsibility on to a power higher than ourselves, so much so that the problem of accounting for man's moral responsibility in a world in which every event is foreordained by God has long been one of the pet paradoxes of the theological schools. In traditional Mohammedanism the authority of God is made complete, and whatever man may strive to do, the final result is always according to "the will of Allah." This is strictly comparable with the role of fate in Greek tragedy, where, as in the case of Œdipus Rex, the hero all unwittingly commits a heinous crime, not through any fault of his own, but because the fates had so decreed. Nevertheless, even in these cases the doctrine of determinism has never been thoroughgoing, for men are continually reminded of the penalties for evil actions and the rewards for good, implying at least a modicum of freedom.

Both the materialist and the theist in philosophy have been hard pressed to find any rational basis for freedom. On the one hand, to the materialist a man is just one type of matter, and all of his actions should follow the same definite physical laws as other matter, following cause and effect to their inevitable conclusion. To the theist, the world, with man as a part of it, represents an aspect of God's activity, for which God himself must be responsible. From Socrates and Epicurus to Kant and Berkeley the philosophical writings echo with the struggle to wrest a rational freedom from a set of postulates which seem to deny its possibility.

For the most part science has been more outspoken than philosophy. Thus La Place, following the traditions of Newtonian mechanics, though not Newton's own philosophy, wrote in 1812:

> We ought to regard the present state of the universe as an effect of its antecedent state, and as the cause of the state which is to follow. An intelligent being who at a given instant knew all the forces animating Nature and the relative positions of the beings within it would, if his intelligence were sufficiently capacious to analyse these data, include in a single formula the movements of the largest bodies of the universe and those of the lightest atom. *Nothing* would be uncertain for him: the future as well as the past would be present to his eyes.[1]

On this view, whatever man may feel regarding his own freedom, in truth he has no conscious control whatever over his actions. Absurd as this conclusion may sound, it is at present a very generally accepted view among certain groups of scientists, although to the physicists, who were its initial sponsors, during the past few decades such complete physical determinism has become less and less probable.

With the recent development (1927) and general acceptance of the principle of uncertainty, no physicist could now subscribe to La Place's thesis. Thus Profes-

[1] Quoted by E. W. Barnes, *Scientific Theory and Religion* (1934), p. 578.

sor Heisenberg, co-author of the principle, writes:

> The resolution of the paradoxes of atomic physics can be accomplished only by renunciation of old and cherished ideas. Most important of these is the idea that natural phenomena obey exact laws—the principle of causality.[2]

Natural phenomena do not obey exact laws. This statement marks perhaps the most significant revolution in the history of scientific thought. For faith in the reliability of nature is the bedrock upon which the structure of science is built. It has nearly always been assumed that this reliability implied the exactness of nature's laws. Has science, with its continual searching of fundamentals, finally undermined its own foundations? Or is it possible that under the new physics a more adequate picture of the world can be drawn, one in which purpose is effective and life again has human meaning?

As one whose experiments have been partly responsible for this dramatic reversal of the physicist's point of view, I have

[2] W. Heisenberg, *The Physical Principles of the Quantum Theory* (1930), p. 62.

been especially interested in tracing what the significance of this change may be to human life and thought. It makes one pause when he finds evidence that an important school of science was once dealt a death blow by the philosophers because its teachings seemed to remove the basis of morality. An adequate solution of the dilemma of freedom and law is thus as essential to the welfare of science as it is to the growth of religion. Does our present-day science rest upon any firmer foundation than that of the ancient Greeks?

Rise and Fall of Greek Science

IT was not the objective of this early science, dating from the sixth century B.C., to obtain knowledge with which to control nature.[3] Rather, with increased knowledge of the world, men hoped to learn the purpose of life and how it should be lived. Pythagoras, by a brilliant combination of experiment and reasoning, laid the basis of the science of sound, advanced the sub-

[3] In this account I have followed closely W. C. D. Dampier-Whetham, *The History of Science and Its Relations with Philosophy and Religion* (1929).

ject of geometry, recognized evolution, and made his unprecedented knowledge of nature the basis of a religious cult. He saw more clearly than any man before him that we live in a world which follows uniform laws. It behooves us therefore, he argued, to learn these laws and to adjust our lives in accord with them. This involved knowledge and self-discipline, for only by discipline can we fit ourselves acceptably to the world. Recognizing that the doctrine was a hard one, he gathered about him a Chosen Few who had as their objective the *spread of the rule of reason and morality.* Both personal and political life should thus be controlled according to the laws of nature learned by careful study. Truly a noble ethic, based on the recognition of law in nature, with ourselves as a part of that nature.

Aware that the necessary knowledge could not be expected of the uneducated masses, it was a corollary that those who know must rule. The inevitable result is dramatically pictured by Alfred Noyes in his *Book of Earth:* The Chosen Few have kept from the citizens of Crotona the "rightful" spoils of war in the interest of a more permanent peace with their neighbors. "Discipline," it is a hard doctrine. There follows an irate mob, and "Death to Pythagoras! Death to those who know!"

Thus ended the Chosen Few; but the recognition that we live in a world of law was passed down through the years to their spiritual successors, the Atomists. "Nothing happens without a cause, but with a cause and by necessity," wrote Leucippus, the father of this new group of thinkers, whose work remains basic to much of modern science. "Of what and how is the world made?" Thales had asked two centuries before. The Atomists found the answer as we would now find it in tiny atoms. Solids, liquids, and gases differ from each other because of the different mobility of their atoms. In the words of Democritus: "According to convention there is a sweet and a bitter, a hot and a cold, and according to convention there is color; in truth there are atoms and a void." Not only stones and seas and air, but life and thoughts as well were thus explained. The whole world of plants and people had been reduced to a vast machine.

Then came that immortal trio, Socrates, Plato, and Aristotle. As philosophers they remain in the highest rank. From the standpoint of science, however, Dampier-Whetham considers the influence of Socrates and Plato as a world calamity. Except for them, he suggests that science might have reached its present stage of development two thousand years ago.

Socrates was a great sceptic; not a critic of religion from the basis of science, but a severe critic of science from the standpoint of philosophy. Recognizing that all knowledge comes to us through the mind, the mind was to Socrates supreme, and the knowledge of which he was most sure was that coming directly from his own inner consciousness. Thus it was natural for him to lead a reaction against the materialistic attitude of the Atomists. Socrates saw that their mechanism left no room for that freedom of choice which is the basis of morality, whereas his reason told him that mind was the controlling factor in men's actions. Perhaps his reasoning was more vigorous than rigorous. For example, when he had been sentenced to death, Socrates told his disciples that every atom in his body was calling on him to escape from Athens. If the atoms were in control, would he not flee? He remained to drink the hemlock because he "thought it more just and honorable to submit to whatever sentence the city might order rather than to flee and run stealthily away."

Though one might criticize the logic of such arguments, their effectiveness is obvious. Science was of value if it led to a satisfactory philosophy of life. Socrates felt that the science of the Atomists had led to a world in which there was no significance to morality and in which human effort was of no avail. Such science was worse than useless.

The destruction of the mechanistic system of the Atomists thus started by Socrates was carried on with logical rigor by Plato. He developed his system of idealistic philosophy to such a high stage that interest in the mechanistic point of view rapidly declined. It was natural that with such a background Plato should be one of the first to call upon his fellow men to make themselves masters of their own destiny, and he himself made an effort, in his "Republic," to explain how the ideal life might be achieved.

It was a great day in the world's history when man first saw that in his own hands he held the power of shaping his own destiny. The value of such a vision cannot be denied, and it could not have been reached on the basis of Democritus' "atoms and a void." It is, however, hard to combine the vision of man as master with that faith in the uniform laws of nature which makes it possible for him to retain mastery. Plato himself had this rare combination. In fact he saw in the exact methods of mathematics a mode of reasoning which he hoped might be extended to the practical problems of life. Plato was responsible for a large part of the geometry of Euclid as well as for a mathematical method closely approaching that of the calculus. This mathematical work very probably helped the astronomical and physical studies of

Aristarchus, Archimedes, and their contemporaries, and certainly formed an essential part of the foundation of modern science from the time of Descartes and Galileo. Thus Plato made notable contributions toward the advancement of science. It was the mechanism of the Atomists against which he was fighting, not the idea of natural law. Only by a tragic perversion of his wholesome criticism of the science of the Atomists were Plato's followers led to an abandonment of the faith in natural law which is so fundamental to all science.

In any case, after Socrates and Plato, the interest in science among the leaders of Greek thought rapidly declined. It is true that Aristotle made many observations of value on animals and plants; but he was still influenced by the Pythagorean tradition. Epicurus introduced also a modified atomism in which men are considered free. Yet as Platonic philosophy gained ground, science became limited to the outlying parts of the Greek world, such as Alexandria and Syracuse. Its decadence was hastened by the influx of

Oriental magic and mysticism following Alexander's conquests, which fitted as glove to hand with the philosophical idealism of Plato's followers. By the beginning of the Christian era the light of science had gone out. Why? It had not produced results of important practical consequence, as later science was destined to do, nor had it proved itself a reliable source of strength and guidance in fighting life's battles, as its proponents had hoped. In this regard its inability to solve satisfactorily the paradox of freedom and law was a crucial fault. Science had thus failed to illumine man's path of life.

Islamic Science and Fate

WHEREAS science made itself objectionable to Greek thinkers because it seemed to imply determinism, in Islam its tendency must have been to strengthen the fatalistic philosophy adopted by Mohammedan religious leaders. The problem of predestination and free will was borrowed from Christian sources, and became a burning question among Moslem theologians. Its discussion, however seems to have been based chiefly upon ethical rather than scientific reasoning. Thus the orthodox Ash'arite school, which defended the view of complete divine predestination, nevertheless "explicitly denied the operation of natural law and the relation of cause and effect."[4] It is doubtful whether Arabic science was ever developed to a stage at which, as in Europe after Newton, its deterministic implications became evident. Nevertheless, as Dampier-Whetham points out,[5] the atomic theory of Epicurus was an important factor in shaping the orthodox Mohammedan philosophy, having become "converted into an intense monotheism." Though the epicurean atomism as transmitted by Lucretius tries to make room for freedom, its more evident implication is the determinism so clearly seen by Socrates. It is hardly possible but that this must have strengthened a fatalistic attitude among the Moslem philosophers to whom "the Cosmos is God."

[4] Alfred Guillaume, in *The Legacy of Islam* (1931), p. 268

[5] *History of Science*, p. 78.

It might have been anticipated that though such a deterministic philosophical attitude might be encouraged by science and in turn assist in bringing on scientific advance, when its moral implications were appreciated it would sap the ambition of its adherents. For why should an automaton make an effort which in any case must be useless? Thus we might expect a rapid decline of interest in scientific and philosophical speculations.

This is as a matter of fact just what history shows. For about three centuries, from 750 to 1050 A.D., Islam was doing the world's important work in science, which, however, then quickly declined, fortunately not until the spark had lit a faltering flame in Christendom. It would be too much to claim that the growing disinterest in science came about solely because those who would have followed science became convinced of the futility of effort in a fatalistic world. Yet it would appear that in Islam as in Greece the fundamental causes of the decadence of science were not political or economic but philosophical and religious. Thus Meyerhof finds:

> Whilst the orthodoxy of early Islam tolerated the sciences, we may say that, from the time of the famous religious teacher al-Ghazali (d.1111) onwards, this tolerance gave way to persecution of these studies "because they lead to loss of belief in the origin of the world and in the creator."[6]

Those acquainted with the effectiveness of the present disfavor in which orthodox Mohammedanism holds higher education will readily accept his conclusion that this persecution was a very important factor in the suppression of scientific study. Thus a second era of science comes to an end because it has failed to help men find a more satisfying way of life.

The fact that neither Chinese nor Indian civilization has developed groups of scientific men of importance comparable with those of the best Greek and Mohammedan periods would seem to show that the conditions under which scientific thought can flourish are indeed critical. Why has such thought grown in Europe during the last six centuries?

[6] Max Meyerhof, in *The Legacy of Islam* (1931), p. 337.

Science Wins Its Way in Europe

THE Western world during the first thousand years of the Christian era was almost completely under the influence of Platonic philosophy. This served as a background not only for Neo-Platonism but also for the Christianity developed by the early fathers. Science was completely displaced by mysticism and credulity that accepted all forms of miracles and magic. But Aristotle's science gradually found its way into Christendom through Arabic channels, and St. Thomas Aquinas set himself the heroic task of fitting this new knowledge into the religious teaching of the day. "*Scientia et religio ex uno fonte*" was the motto, and with it came renewed interest in knowing the world of nature, for thus one might learn regarding the works of his Creator. Roger Bacon and Leonardo were among those who saw the need for first-hand inquiry into nature's secrets, with the hope that man might thus be gifted with new powers. The early scientific societies, such as the Royal Society, stimulated scientific discussion and experiment. Copernicus revived the heliocentric system of Aristarchus, which was startlingly confirmed by Galileo's new telescope. The culmination of this revival of science came when Isaac Newton established the laws of motion of bodies acted on by forces, and showed how, by introducing the simple concept of gravitation, harmony came into the motion of the planets.

Science had succeeded in explaining things that had puzzled the world for ages, and in this explanation everything obeyed exact laws.[7] The effect of this achievement of Newton's on men's view of their world was tremendous. Burtt de-

[7] My colleague Professor Carl Eckart calls my attention to the fact that Isaac Newton himself did not adopt the principle of physical determinism. Newton's own statement of the law of causality is given by his friend Henry Pemberton in his book, *View of Sir Isaac Newton's Philosophy*. In discussing the kind of proofs which science can supply, Newton is there credited with laying down the following simple precepts:

"The first is, that more causes are not to be received into philosophy than are sufficient to explain the appearance of nature . . .

"The second precept is the direct consequence of the first, that to like effects are to be ascribed the same causes."

The first of these precepts is exactly the basis of what Kantian philosophers would call phenomenalism, which scribes graphically the attitude which came to be accepted as the "scientific" attitude:

> The world that people had thought themselves living in—a world rich with color and sound, redolent with fragrance, filled with gladness, love and beauty, speaking everywhere of purposive harmony and creative ideals—was crowded now into minute corners in the brains of scattered organic beings. The really important world outside was a world hard, cold, colorless, silent and dead; a world of quantity, a world of mathematically computable motions in mechanical regularity.[8]

After two thousand years men had returned to the doctrine of Democritus: "According to convention there is a sweet

is today recognized as the most satisfactory basis for approach to scientific problems, and was specifically used by Heisenberg as the background for his development of quantum mechanics. The second, as is evident from the context, is intended as a carefully considered statement of the law of causality. It will be noted that this statement is in no way contrary to the conclusions we shall draw from the Principle of Uncertainty.

The seventeenth-century mechanists were so impressed with the elegance of Newton's laws that they overlooked his philosophy. The deterministic aspect which they gave to science need never have been present, as Schrodinger has clearly shown in his *Science and the Human Temperament* (1935).

[8] E. A. Burtt, *Metaphysical Foundations of Modern Science* (1925), p. 236.

and a bitter, a hot and a cold, and according to convention there is color; in truth there are atoms and a void."

The history of Greek thought suggests that men must pass through such a stage of mechanism, which reduces human effort to a meaningless concourse of atoms and takes away all basis for morality, in order that they may see that such a philosophy cannot describe the really significant things of life. As when Socrates pilloried the Atomists, so again Leibnitz and Kant and Berkeley reacted against the too easy materialism of Hobbes and La Place and Voltaire. Their analysis of the problem made logically untenable the position that man is a machine; yet it was no longer possible to laugh science out of court, for science had achieved results of undeniable value. Men had too much common sense to abandon again the great truths that it had given. If nature was one unbroken chain of law, they would learn that law to master nature. The philosopher might worry, if he wished, over the fact that the strife for mastery is meaningless to a man who is merely a link in this unbroken chain.

For the last two centuries the man of science has thus of necessity blinded himself to the logical inconsistency of his position. He has felt that he must have faith that his world is one of law, else it seemed his search for truth must be futile. He must not pause to consider that if his own actions are "with a cause and by necessity" he cannot in truth "make a search" at all.

Now, Heisenberg tells us, science must abandon its cherished law of causality. His case has been made so convincing that I should consider it more likely that the principle of the conservation of energy or the second law of thermodynamics would be found faulty than that we should return to a system of strict causality. Many physicists, headed by Planck and Einstein, would not agree to this estimate of the fundamental and permanent character of Heisenberg's principle. It is probably safe to say, however, that among those who have been actively engaged in the development of the new quantum mechanics, and who are thus most familiar with its bases and implications, the view I have expressed would be almost unanimous. Thus suddenly the bone of contention between the physicists and the philosophers has disappeared. How has this come about? How do the new findings affect the age-old riddle of freedom in a world of law?

II.

WHAT DETERMINES OUR ACTIONS?

According to classical physics, and especially mechanics, it would be necessary to undertake certain operations in order to take a particle to a given place at the initial instant and in order to impress upon it a given velocity. Thus we might take it between nippers, carry it to the place in question and push it in an appropriate direction. Quantum mechanics teaches us that if such an operation is undertaken with a particle a great number of times, the same result does not invariably come about even if the operation is always exactly the same. But it further teaches that the result obtained is not entirely a matter of chance. What is claimed is that if you repeat the same experiment a million times and register the frequency with which the different possible results occur, they will in a second million experiments repeat themselves with very nearly the same frequency.

ERWIN SCHRODINGER, 1935.

IN the first chapter we reviewed the history of the contest of freedom versus law down through the ages. On the Greek arena, freedom won the battle so completely that science did not recover for a thousand years. In Islam the triumph of law as represented by fatalism deadened incentive toward scientific advance. On the modern battlefield, law since the time of Newton has had rationally the upper hand; but stubborn common sense has refused to relinquish its hold upon freedom. In religions and philosophies the echoes of the battle have been continually heard. During the modern period it has been the complete acceptance of the absolute determinism of the physical world following the successes of Newton's mechanics that has made it so difficult to justify belief in our freedom of action. It seems unfortunate that some modern philosopher has not forcibly called attention to the fact that one's ability to move his hand at will is much more directly and certainly known than are even the well-tested laws of Newton, and that if these laws deny one's ability to move his hand at will the preferable conclusion is that Newton's laws require modification. Yet I suppose such an argument would have been scorned by the physicist, who has found it necessary to show in his own way the inadequacy of Newton's laws.

The physicist has rarely concerned himself with the actions of living organisms. He has assumed the universal applicability of the laws which he finds in the inorganic world, but has seldom bothered himself with the fact that if a completely deterministic set of laws such as those of Newton apply to man's actions he is himself an automaton. It would be a mistake to infer that physicists have always taken a mechanistic position. On the contrary, probably most of us have had an ill-defined idea that in our own actions some influences are effective which are not describable by physical laws. We have preferred merely to pay no attention to the difficulties of this position. If no other factors are effective in human life than those included in electrodynamics (the basis of modern mechanics) we are in truth merely complicated machines; whereas if other factors are significant, our laws of physics are incomplete descriptions of the world in that they do not describe our own actions. It would seem that one of these alternatives must be chosen. It is of obvious importance to the physicist that he shall know the realm within which his laws are applicable, and how far they are adequate to give a complete description of the world.

As a physicist, my chief interest in the present study has been in the finding that even if we assume men to be really free, the laws of physics as we now know them may nevertheless be considered universally valid. We must in this case however suppose that the world has certain attributes, which may be distinguished from physical attributes by the adjective "psychic," which are additional determining factors in the actions of living organisms. That is, there is no reason from a consideration of the actions of living organisms to doubt the universal validity of the laws of physics; but these laws are insufficient to make possible an exact prediction of such actions. In so far as motives may be effective in determining actions of living beings, the laws of physics, however well verified by experiment, must be considered as giving an incomplete account of nature. This incompleteness lies merely in the fact that if true freedom is postulated, with a knowledge of motives, a more accurate prediction of the actions of a living being is possible than can be made from a knowledge of the physical conditions alone.

The statements of the laws of mechanics by Newton, and of electrodynamics by

Maxwell and Lorentz, leave no room for such extra-physical factors as motives to play a determining role. The world as described by classical physics was thus necessarily determinate.[1] According to this system, the philosophers' "moment of choice," when psychic influences determine which action an organism shall follow, is a futile concept, since the motion of every molecule is predictable on the basis of the previous history of the world without taking such things into account. As we shall see, this difficulty does not apply when we use the form of mechanics supplied by the quantum theory, because according to this theory the past history of the physical world is an insufficient basis for the exact prediction of its future state. For this reason it is no longer justifiable to use physical law as evidence against human freedom.

[1] In his recent book, *Science and the Human Temperament,* Erwin Schrodinger shows, however, that even if the laws of Newton and Maxwell were found to describe the events in the physical world within experimental error, the deduction of a deterministic world would not be a necessary consequence. Such determinism follows only if these laws are assumed to be exact beyond the possibility of experimental test.

We have noted that Newton's laws were formulated on the basis of experiments with objects of ordinary size, projectiles, pendulums, and the like, and had their first highly precise tests when applied to problems of astronomy. A great achievement came, for example, when he showed that the moon revolving around the earth obeys the same formula as does the apple falling to the ground. During the past generation, however, physicists have concerned themselves with what goes on within the atom. This they find is made up of electrons, protons, and neutrons in continual motion and in various states of combination. At first we supposed that these excessively minute particles would obey the same laws as those discovered by Newton and his followers governing planets and projectiles. When, however, these laws were subjected to test on this very small scale, they were found to be wholly inadequate. After years of confusion a new set of laws of motion has emerged, which become identical with those of Newton for large scale events, but on a small scale give strikingly different results.

Replacing the exact predictions of astronomy, we have on an atomic scale laws of statistical probability.

It was Heisenberg, while a student at Göttingen, who found the key which unlocked the door. "Let us not read into these particles," he said, "the properties that we find in ordinary things, but content ourselves with noting how they act, and with describing their actions in a systematic manner." At once the atmosphere cleared. We had supposed that the electrons revolved in orbits within the atoms; now we found that these orbits were a gratuitous assumption—there was really no evidence of their existence. But more startling was the fact that when an attempt was made to predict where any electron would be at any future moment, it was learned that however much we might know about its position and motion now, its position at a time in the future could not be accurately foretold. We might predict the average result of many trials; but no conceivable physical experiment could tell us just where a particular electron would be at a definite future time. That is, the laws of the new physics cannot predict an event; they tell only the chance of its occurrence.

The Principle of Uncertainty

SUPPOSE, for example, we want to measure the speed of a rifle bullet, and so predict when it will reach a certain point. Let us place a fine wire close to the muzzle of the gun, and another wire perhaps ten feet away in the path of the bullet. We shall record electrically the times of breaking of the wires. Suppose the second wire breaks a hundredth of a second after the first. The bullet was then going at a thousand feet per second. But if the third wire is placed ten feet beyond the second, will the bullet break this wire in another hundredth of a second? Not quite, for the bullet was slightly slowed down by the second wire. Thus we cannot predict exactly where the bullet will be at any later time from observations of the time of breaking the wires.

We might remove this uncertainty by removing the wires and allowing the bullet to cast shadows as it passes two photoelectric cells placed ten feet apart, and thus we might predict reliably the future position of the bullet. Yes, but not quite reliably; for the light will exert a slight pressure on the bullet as it passes the photoelectric cell, and deviate it slightly from its course. This effect will obviously be very small, much too minute to notice in such an experiment; but it is effects of just this kind that introduce the uncertainty with which Heisenberg is concerned. In order to reduce the effect of the light pressure on the bullet, let us reduce the intensity of the light beam. If light were infinitely divisible, we could thus make the effect of light pressure as small as we pleased. But recent experiments have shown that a light beam consists of a stream of particles—photons, we call them. Thus if the bullet is to cast a shadow it must intercept at least one photon, and the impact of this photon alters the motion of the bullet by a small, unknown amount.

The bullet must affect something in order that its time of passing the two stations can be observed. But in producing this effect its motion is changed. Thus its future motion cannot be predicted exactly from a knowledge of its past history.

Is there not, however, something which has smaller mass than a photon of light, and which will not interfere appreciably with the bullet's flight? Yes, there is a photon of radio rays. The mass of the photon varies inversely as the wave-length of the ray. Thus for a three hundred meter radio wave the mass is much less than for a light wave that is less than a thousandth of a millimeter in length. But if we use a radio ray, we cannot note the position of the bullet to closer than about one wave-length, and this makes a definite prediction of its future position impossible. Nature has so conspired that if we try to make the momentum of our detecting ray negligible by using a long wave-length, we are unable to tell the position of the bullet precisely; and yet if by using light of short wave-length we note accurately its position, the momentum of our photon is so large as to give a relatively great uncertainty to the bullet's motion.[2] Thus we

[2] In simple mathematical terms this can be stated as follows. If we wish to predict the future position of an

are balked in predicting the future position of the bullet by the dual wave and particle characteristics of light.

Might we not, however, use something other than a beam of light to observe the bullet's motion? We shall naturally use the smallest probe that we can devise. An electron or a proton or an atom suggests

object moving uniformly along a straight line, we must know accurately the starting position S and the initial momentum P. The uncertainty of position δS is approximately equal to the wave-length L; whereas the uncertainty in the momentum δP is roughly equal to the momentum h/L of the particle associated with the wave, where h is the constant of the quantum theory, known as Planck's constant. Thus the combined uncertainty of the position and momentum of the object can be written as

$$\delta S \times \delta P = L \times h/L = h.$$

This means that this combined uncertainty has the same value h whatever the wave-length of the detecting rays.

It will be noted that in writing this equation we have not specified the nature of the particle or the wave. Louis de Broglie has given a convincing proof that any kind of particle, whether atom, electron, photon, or even a bullet or a planet must have associated with it a wave (which is not material, but whose strength tells the probability of presence of the particle) whose wave-length is $L = h/P$. This theory has been confirmed by experiments with photons, electrons, atoms, and molecules. Heisenberg shows that the above equation for the combined uncertainty of position and momentum is a necessary consequence of De Broglie's law. Thus the same uncertainty in prediction of the particle's motion should be present whatever material means is used for detecting its initial position.

itself; but when we investigate the effects of these objects on the bullet's motion, we find them identical with that of a light ray. This is because our experiments have shown that a wave is associated with each of these objects, whose wave-length is likewise inversely proportional to the particle's momentum.

When applied to the motion of a bullet, these uncertainties are so exceedingly minute as to be wholly beyond detection. They should become barely perceptible for the tiniest objects seen under a microscope. But when we consider the motion of such minute things as atoms and electrons and photons, the uncertainty as to the future condition becomes so great that it is frequently impossible to make any prediction at all. This uncertainty arises merely because in ascertaining the particle's previous history we have affected its motion by an unknown amount.

Did you ever notice the starlike pattern of a street lamp as you look at it through an umbrella? This is due to the diffraction of the light as it passes through the small holes between the threads of the cloth. An ocean wave is similarly diffracted when it spreads out after passing through the entrance to a harbor.

Now imagine, as in Figure 1, a faint ray of light passing through a tiny hole, which then spreads by diffraction into a broad beam. In the path of this broad beam we may place two photoelectric cells, each connected with an amplifier. These will be made so sensitive that the entrance of a single photon into either cell is recorded. A shutter in the path of the light ray remains open long enough to transmit a single photon. Into which cell will the photon fall?

There is no way in which we can be sure. The photon follows the light wave, and if we try to make its path more definite by using a smaller hole to transmit the ray, we merely make the transmitted beam more diffuse by diffraction. Though the first photon may enter one cell, with the initial conditions identical as far as any test can show, the next photon may enter the other cell. Possible tests would be to vary by measured small amounts the positions and widths of the slits and the wave-length and state of polarization of the light. We should find that such changes would make but small differences in the results of the experiment, the number of photons entering cells A and B remaining nearly the same. Attempts to observe a photon itself before entering the photoelectric cell would spoil the experiment, for to make such an observation it would be necessary for the photon to encounter some material object placed in its path. Such an encounter—and here is the essential point—would so disturb the motion of the photon that it would not help us in predicting its subsequent course. A collision of the photon with even so light an object as an electron would completely alter its motion. For successive photons transmitted by the shutter the conditions of the experiment are thus identical as far as any test can show, yet the result is not reproducible. It is, as far as we can see, truly a matter of chance. That is what we mean by saying that the law of causality does not hold: knowledge of the initial conditions does not enable us to predict what will happen, for with the same initial conditions we cannot consistently produce the same effect.

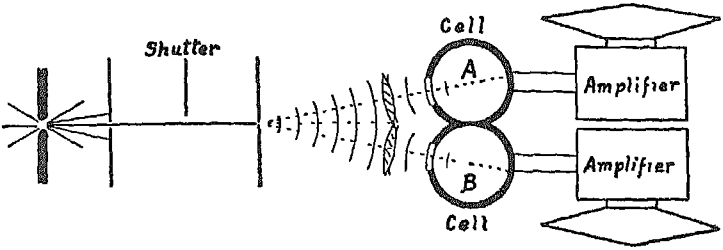

FIGURE 1

Nature does not obey exact laws. On successive trials, photons of light which traverse the slits do not always enter the same photoelectric cell.

The Physical World Not a Determined System

DOES this, however, mean that for the photon the law of causality that all things happen "with a cause and by necessity" is no longer valid? It means at least that no physical experiment can test this principle on an atomic scale. One might still retain the principle as a postulate, supposing that there are some qualities of the photons and electrons which our experiments cannot reveal that, nevertheless, determine which of the many possible paths the particles will follow. Thus "good" photons might pass into one photoelectric cell, and "bad" photons into the other, and a daemon controlling the shutter might be conscious of their qualities. Yet if these qualities cannot be revealed by experiment, it makes no experimental (that is, physical) difference whether they exist or not. Thus it is as a physical principle that the law of causality must be abandoned. The philosopher may retain the idea of rigid law as applied to "things in themselves" if he so desires; but he cannot refer to experiment for its verification.

It would seem however that the most satisfactory position that can be adopted as the basis for scientific study is that which Kant describes as the "phenomenalist" view, and which has recently been developed under the name of "operationalism." A phenomenalist assumes that only those aspects of the world have reality which are capable of showing themselves in some way to the observer. Thus attributes of a photon such as the "good" and "bad" qualities that we have imagined would not be real to the phenomenalist, merely because it makes no difference in any experiment with photons whether they are "good" or "bad." Since it makes no difference, the phenomenalist would argue, the distinction between "goodness" and "badness" is meaningless, and therefore has no reality.[3]

Whether we take the view that our thoughts are the product of brain activity, or the alternative position that the brain

[3] A form of phenomenalist position frequently adopted by scientific men is that unless a supposed quality is capable of revealing itself by some physically detectable effect, it makes no detectable difference whether an object has this quality or not, whence to say that an object has this quality is a statement without meaning. All such physically undetectable qualities are accordingly dismissed as having no reality.

The philosophical idealists from the time of Plato have had an objection to this form of phenomenalism which would seem to be fatal. Suppose a thought occurs to me —let it be a thought of the number *3*. If to such a phenomenalist the statement that I think of the number *3* has any significance, it must make a physically detectable difference whether I think of this number or have some other thought. It may be that the nerve or brain currents associated with this thought are of a type that is potentially distinguishable in its physiological characteristics. My awareness of the thought is however in no way dependent upon my ability to distinguish such characteristics of the brain currents. It is in fact only when a physical change has by some complex method made itself evident to my consciousness that I am aware of its existence, whereas I have the same awareness of the thought without the complex and questionable intermediate processes. My immediate awareness of the thought is therefore a much more fundamental kind of knowledge serves as the organ for intercommunication between consciousness and the body, in either case the evidence is convincing that associated with certain brain conditions there are corresponding states of consciousness. We thus have a recognizable attribute of the matter of which our

than is that of a fact which is recognizable only through some physically detectable change. The physical phenomenalist's test would in fact leave doubtful the reality of my own thoughts and their qualities, which are precisely those things of whose reality my knowledge is most direct and unquestionable.

Not long ago a friend tested my reactions on a "lie-detector" which he had developed for taking evidence in court. Along my arm were placed two electrodes, which through an amplifying system and a galvanometer made a record of electric potentials associated with my heart-beats. I was given a suite of thirteen cards, and told to name one to myself. The operator then asked me to reply "no" each time he indicated a particular card. When he came to the deuce of hearts, which I had selected, my answer was untrue. The galvanometer record showed a distinctive fluctuation when I gave my answer, showing that the statement was false, and my friend correctly identified the deuce of hearts as the card chosen. The distinction between truth and falsity was thus made physically detectable. Which however was the more fundamental criterion, my own awareness of the truth or falsity of my statement, or the shape of the galvanometer curve? Though the operator of the instrument might rely more confidently upon his record than upon my statement as to which card was chosen, my immediate awareness of the truth or falsity of my statement was necessarily the standard against which the reliability of the "lie-detector" itself must be tested. To have based the distinction between the truth and falsity of my brains are composed, namely, the associated state of consciousness, which is not detectable by any known type of physical test. Negation of such consciousness because of its physical undetectability would mean the denial of the basis of all knowledge.

In order to interpret men's actions, it

statements upon the physical detectability of their differences would have made the test meaningless. The premise that the meaningfulness of a quality is to be judged by its physical detectability is thus indefensible.

If, *however, we extend our postulate by admitting not* only differences which are physically detectable, but also all differences which are evident to our consciousness, this difficulty is removed, and the phenomenalist or the operationalist position again becomes tenable in a broadened form. The idealist will at once point out that since I cannot know physically detectable differences except as they are made evident to my consciousness, the criterion that one may be made aware of the differences is a sufficient test of their reality. To this I agree; yet it remains convenient to distinguish between those differences of which we are immediately aware, and those which become evident to us indirectly because of some physical change that is effected. It is solely with differences of the latter type that physical science is concerned; yet if we are to attempt to interpret the actions of intelligent organisms it is evident that we must include both types of differences as having meaning. So though we may accept physical phenomenalism as a satisfactory basis for investigation of scientific subjects, it is not broad enough to cover all of our experience. In particular, we may expect this position to be inadequate for the discussion of our present problem of what determines man's actions, since such actions appear to be limited by both physical and psychical conditions.

appears to me desirable to assume that the matter in our brains may occur in conditions which though physically indistinguishable nevertheless correspond to distinguishable states of consciousness. Thus we may assume that we are directly conscious of certain thoughts, corresponding to a particular state of certain brain centers, whereas physical tests would at best be able to determine only the statistical probability of this state. Such an assumption is not contrary to the spirit of phenomenalist philosophy, since by hypothesis this state is distinguishable by the nature of our thoughts. It seems to me necessary to make some such assumption if consciousness is to be of any value to the organism.

It will clarify my meaning if we consider again the being who is immediately aware of the differences between the photons of Figure 1 in terms of which he can predict which ones will enter chamber *A* and which chamber *B*. These will necessarily be differences which are physically undetectable, but would show themselves real if by his awareness of their quality the being were able to predict which way each photon would go. In terms of such properties the motion of the photons might well be completely determinate.

Einstein, while admitting the correctness of our present quantum mechanics, has recently called attention to an apparent incompleteness in this theory of the world. It is incapable of describing simultaneously both the position and the velocity of the bullet which we have considered above. He admits that there is no known method whereby both quantities can be simultaneously measured with precision. Yet, if I understand him correctly, Einstein takes the view that since either the position or the velocity may itself be precisely measured, both are definite quantities, and a complete theory should make possible an exact knowledge of them both. Other physicists, such as Bohr, answer by noting that a strength of the quantum theory is that, contrary to Newtonian mechanics, it ascribes meaning to position and velocity only in so far as we may hope to measure them by experiments using material (i.e., anything having mass or energy) instruments. Nature is not, they say, more completely definable or predictable than such measurements would imply. Those who have been intimately connected with the development of the new quantum mechanics would strongly favor the latter position. Those long schooled in the classical tradition and who have observed from without the growth of the new ideas would probably for the most part side with Einstein.

The strong support of Einstein's position is the fact that in nature definite events occur, which according to present theory cannot be definitely predicted. Thus in Figure 1 in a particular experiment the photon may produce a sound in loudspeaker *A*. This is a definite fact which we were unable definitely to predict. Einstein and his followers remain unsatisfied with such a state of physics. We must be overlooking something, they feel, which would make such a prediction possible.

It seems to me that in the development of the quantum mechanics by Heisenberg and others, it has been well established that no more precise information about the state of motion of a particle, for instance, than that admitted by the quantum theory can be got by any kind of physical experiments. By this I mean that if the duality of wave and particle characteristics apply to all forms of matter, as both theory and experiment seem to indicate, Heisenberg uncertainty is inescapable in any observation which uses a material detecting instrument. If then the definite predictions sought by Einstein are to be realized, it must be through the use of information obtained without using material detecting instruments. The only other means of gaining knowledge with which we are acquainted is through the immediate awareness of some conscious being. If Einstein's suggestion of a definitely definable world is to make sense to a phenomenalist, therefore, it would seem that the properties assumed to supplement the data included in quantum mechanics must be such as to produce direct effects upon consciousness. This would mean that, in addition to the physical data supplied by observations with material instruments, psychical data acquired by direct consciousness are necessary if we are to define or predict events with exactness. I should add that this conclusion does not reflect any well-recognized body of scientific opinion, but is nevertheless rather a result which appears to me as inescapable.

We should not think of the lack of exactness, in the world which our experiments reveal, as meaning a loss to science. Heisenberg has shown that if the principle of causality is replaced by the principle of uncertainty, all those paradoxes of atomic physics that have been classed as "quantum phenomena" find a ready solution. This includes such things as the photoelectric effect and the emission of light. Nor has the classical dynamics of projectiles or planets been in any way affected. Science has indeed gained greatly by introducing this flexibility into its most cherished law of cause and effect.

Uncertainty in Large Scale Events

WE have seen that nature's erratic character is to be observed in the motions of the very small things rather than in ordinary or large scale events. There are, however, conditions under which the uncertainty in a small scale event may result in an equal uncertainty in an event of great magnitude. In the experiment suggested with the ray of light passing through a tiny hole, we might connect one of our amplifiers with an electrical device which will explode a stick of dynamite, and the other amplifier with a switch which will open the circuit. Now what will happen when the shutter transmits a photon? If it enters one cell the dynamite will explode, and the apparatus will be blown to bits. If the photon enters the other cell, the switch will be pulled and the apparatus is no longer in danger. Both events are equally probable. Any event therefore which depends at some stage upon the outcome of a small scale event is essentially unpredictable on the basis of previous history.

As another example, consider an experimenter who is working in the laboratory with apparatus such as we have described, and notes from his watch that it is time for lunch. He decides that when the next photon enters photocell *A* he will go home. After several trials, amplifier *A* announces this event. He stops his experiment, picks up his hat, and departs. Here is a human action which is definitely subject to Heisenberg uncertainty.

Professor Ralph Lillie has pointed out that all deliberate actions of living organisms seem to be events of this kind.[4] Such actions are occasioned directly by certain nerve pulses, which are presumably electrochemical reactions on a minute scale. Our deliberative processes are probably associated with similar reactions, each involving a rather small number of molecules, and hence having an appreciable uncertainty. The sensation which starts the nerve pulse may itself be initiated by a small number of elementary events, such as a hundred photons of light entering the eye. The living organism, in turn, acts as an amplifier of very great power, which may be set in operation by events on a scale comparable with the elementary events which we know to be indeterminate. Considering the complexity of the small scale events associated with any of our deliberate acts, one may say with assurance

[4] Ralph Lillie, *Science* (1927), *46*, 139.

that on a purely physical basis the end result must have a relatively great uncertainty.[5]

As far as the physics of the question is concerned, however, though the action of an individual organism is not definitely

[5] (Technical note.) We are neglecting here the effect of a possible cerebral equivalent of a persistent ideal which forms the basis of choice, as discussed below (footnote, p. 58).

Attention has frequently been called to the fact that nerve and brain reactions should be subject to uncertainties due to thermal (Brownian) motions as well as those of the Heisenberg type. For ordinary molecular motions, the thermal uncertainties are the greater; for chemical reactions, however, Heisenberg uncertainty is of predominant importance. The following paragraphs dealing with this point are included for my physics colleagues who may read this discussion.

The two types of uncertainty are of the same order of magnitude when

$$\tfrac{1}{2}\, kT = h\nu,$$

where the left side of the equation represents the average energy of the motion of a molecule in a given direction, and the right hand side is the energy quantum for an oscillator of frequency ν. The term k, known as Boltzmann's constant, is 8.6×10^{-5} electron volts per degree; T is the absolute temperature; h, Planck's constant, has the value 4.2×10^{-15} electron volt seconds For a particular molecule, the critical temperature T_c at which this equation is satisfied is roughly the same as the critical temperature Θ of Debye's specific heat theory. For molecules which enter into brain structure, T_c is only a small fraction of body temperature. This means that for all molecular movements in the brain, Heisenberg uncertainty is negligible compared with the uncertainty from thermal motion. On the other hand, for the electrochemidetermined, its behavior should obey certain laws of probability. There is not necessarily any suggestion here of an

cal reaction associated with a nerve current, the energy of the reaction for a single molecule will be of the order of

$$h\nu = 1 \text{ electron volt},$$

whereas for body temperature,

$$\tfrac{1}{2}\, kT = 013 \text{ electron volt},$$

that is, the energy quantum associated with the excitation of a brain molecule will be many times the energy of molecular motions. In this case thermal agitation is incapable of producing the electrochemical change of the molecule, whereas the probability of such a change occurring is subject to Heisenberg uncertainty.

As an illustration, let us suppose that the choice between two possible modes of action corresponds to which of two paths will be followed by a pulse propagated along a cerebral nerve fiber when the pulse reaches a fork in the fiber We may imagine molecules on branches A and B of the fork both equally in the (electromagnetic) field of the nerve pulse approaching the junction. If a time of more than a very small fraction (10^{-6} or more) of a second elapses before the "choice" is made, the situation of molecules A and B under the thermal agitation of the neighboring molecules will be statistically nearly identical. We may suppose that if molecule A receives the excitation from the trunk line, the disturbance will pass only along branch A, and vice versa. *Under these circumstances the phenomenon is as completely subject to Heisenberg uncertainty as is the experiment described by Figure 1, thermal fluctuations playing no part in the phenomenon.*

Though we do not know that the mechanism just suggested is that which is followed in the brain, as an example it serves at least to show the legitimacy of the assumption that Heisenberg uncertainty is a critical factor in deliberate acts.

ability of the organism to choose a course of action. Its erratic actions may correspond merely to its lack of skill. If physics were all, I should thus be inclined to suppose that the actions of living organisms including men, like the events in the non-living world, should follow the statistical laws of chance.

A New Determinism—Man as Master

YET, is it possible in terms of chance to account for men's actions? It was sometime ago when I wrote to the secretary of Yale University agreeing to give a lecture on November 10 at 5 P.M. He had such faith in me that it was announced publicly that I should be there, and the audience had such confidence in his word that they came to the hall at the specified time. But consider the great physical improbability that their confidence was justified. In the meanwhile my work called me to the Rocky Mountains and across the ocean to sunny Italy. A phototropic organism could not tear himself away from there to go to chilly New Haven. The possibilities of my being elsewhere at this moment were infinite in number. Considered as a physical event, the probability of meeting my engagement would have been fantastically small. Why then was the audience's belief justified? In the words of Socrates, is it not because I am a man of honor that I have come? They knew my purpose, and my purpose determined that I should be there.

There can be no doubt but that such purposes are effective. If I will to move my arm, my arm moves, so by the only kind of test that has meaning I find that, within certain limits, I can do as I choose. This observation is, however, not sufficient to show that I am free. Why do I will to move my arm?

A position frequently held by those who assume a deterministic world is that consciousness is so coördinated with the brain that whenever the physiological conditions require a course of action we are conscious of choosing to perform this action.[6] Our purposes are "effective," and we feel "free," since what we choose to do is done;

[6] Cf., e.g., F. Nietzsche, *Beyond Good and Evil*, §19.

yet we are in no way responsible for our actions, because our wishes themselves are the necessary outcome of our past history and are not subject to our own control.

The most cogent objection that I find to this hypothesis[7] is the complete uselessness of consciousness to the organism with which it is associated if the view is correct. If it is really ineffective, why should such an extraordinary thing as mind have evolved in association with certain types of organisms? It is an almost universal rule that in the evolutionary process those characters which are of value to a species persist and are accentuated, whereas those that are useless become vestigial or disappear. We find that among the higher animals the course of evolution has brought consciousness to an ever higher level of development. Why should this occur if consciousness were of no value to the life of the animal, and how could it be of value to

[7] An obvious, though perhaps superficial, difficulty with this hypothesis of parallelism is that it affords no explanation for the feeling of compulsion that accompanies the performance of acts against one's will. The hypothesis as stated would imply that we choose to perform our every act, which is contrary to experience.

the animal if it were incapable of affecting its course of action?

The reply is sometimes made that consciousness may be a by-product, similar to the lactic acid secreted by tiring muscles, which though useless may be an inescapable accompaniment of the functioning of the brain. Perhaps as good an answer as any to this objection is the statement made by Huxley in his *Elementary Physiology*, "How it is that anything so remarkable as a state of consciousness comes about as a result of irritating nervous tissue, is just as unaccountable as the appearance of the Djin when Aladdin rubbed his lamp." There is, in other words, absolutely no reason to expect such a nonphysical thing as consciousness to be the by-product of a physicochemical nerve current.

The main arguments for the view that our actions are mechanistically determined are (1) the assumption of a determined physical world, and (2) the predictability of a person's actions.[8] We now

[8] Professor Selig Hecht has given a modernized presentation of the mechanistic argument in an article, "The Uncertainty Principle and Human Behavior," which appeared in *Harper's Magazine* for January, 1935. He

know that events in the physical world are not definitely determined by past history, and we have seen that uncertainties of the Heisenberg type may very probably be of significance in the actions of organisms with nervous systems. Thus the first argument no longer carries weight. Regarding the second, there exists no difficulty on the hypothesis of freedom in accounting for the degree of predictability of a person's actions which experience shows. Physical, including physiological, laws fix the probability of various modes of actions,

abandons the argument against freedom based upon physical determinism, though he notes as we do here that the uncertainty principle does not require freedom. Hecht concludes that freedom is a fiction. His two main points are first, the predictability of men's actions, and second, the fact that in laboratory tests of behavior men's responses are of the same kind as those of lower organisms. The former argument is discussed sufficiently in the text Regarding the latter, we go still further, and find human actions similar in kind to those of atoms—a view which conforms with Hecht's definition of biological mechanism We note, however, that laboratory tests, being of a statistical nature, must fail to detect the distinctive characteristics of the individual actions which may be due to conscious choice. Thus the laboratory method which Hecht employs is just as incapable of finding effects due to human freedom as our studies were of detecting an imagined freedom of photons diffracted by a slit Since he does not consider the relations of a man's thoughts to his actions, his mode of approach cannot conceivably reveal effective freedom even if it exists.

and if in addition we know the ideals on the basis of which a person's choices are formed, prediction of his actions in a given situation can be made with some assurance. We shall see below that it is permissible to assume that such psychic factors determine actions which from physical considerations alone would be a matter of chance. Physically determined actions would on the other hand mean the assumption of the complete physical determination of these ideals,[9] which would beg the question at issue unless some proof of such determination can be found. The physical determinist's position is thus a weak one. It nevertheless does not seem to

[9] It is imaginable that the formation of an ideal or objective in the mind may correspond to the formation of a particular pattern of paths of nerve currents which establishes itself in the brain, and is in turn the background determining the course of all future nerve currents. We could thus arrive at a mechanistic view of deliberative actions without introducing an effective consciousness. Perhaps future psychological studies may inform us whether anything of this kind occurs.

That brain activity may be physically determined is possible if all the brain's activities are on a sufficiently large scale to make Heisenberg uncertainty and that due to thermal motions of negligible importance. The present state of knowledge appears to me opposed to this assumption.

be demonstrably false on the basis of our present knowledge of brain structure and its relation to consciousness. Thus Bergson's conclusion that "cerebral activity corresponds to only a very small part of mental activity,"[10] though supported by a careful analysis of the available evidence, has not prevented other psychologists from continuing to assume a complete parallelism. The evidence for the value of consciousness is on the other hand very weighty, and this would imply that consciousness has a part in determining the actions of organisms. The net result of such arguments seems to me to favor strongly the position of true freedom.

I may confess, however, that even if logic appeared to favor determinism, as it has at many stages of our scientific knowledge, I should be unable to avoid a strong scepticism of a conclusion so contrary to the dictates of common sense. Socrates' contention that the knowledge which comes to us intuitively through direct experience is of a more fundamental kind

[10] Bergson, *Mind-Energy,* p. 57.

than that based upon intricate arguments concerned with delicate tests still carries great weight. Morality has proved itself a vital factor in human advancement. That it pays to try is even more basic in our psychology than is the will to live. But all this is without true meaning if consciousness is ineffective. Such are the considerations that lead me to assume that we are truly free to choose our own actions.

Granting then that a man can choose his own course of action, is there any way in which his physically undetermined actions may be determined by nonphysical means without violating the laws of the physical world? Let us consider an imaginary mechanism, which, while perhaps somewhat fantastic, will show that determination of an event by nonphysical factors need not involve violation of physical laws.

It has been pointed out that the direction in which a particular photon will go after passing through the hole of the diffraction apparatus described in Figure 1 might conceivably be predicted in terms of certain characteristics which are not susceptible to physical observation. The daemon controlling the shutter[11] might consider a photon which would enter the photoelectric cell which would result in exploding the dynamite a "bad" photon, and one which would enter the cell where it would prevent the catastrophe a "good" photon. Being directly conscious of these nonphysical characteristics which will determine their direction, the daemon may then close the shutter to all approaching "bad" photons until a "good" photon has passed through and saved the day. Has the daemon in this way contravened any physical laws?

According to the physics of the situation we supposed that a photon could enter either the upper or lower cell with equal probability. The physical conditions were incapable of determining which cell

11 It is not necessary that the daemon should produce any physical action. The emission of the photon by the light-emitting atoms is a matter of probability, subject to Heisenberg uncertainty. We may imagine that the daemon is conscious of the quality of photons that may be emitted and chooses that a "good" photon shall come first. In accord with the discussion in the text, such a choice of a single event does not disturb the statistical probability of emission.

any particular photon would enter, but were so adjusted that over a long period of time the numbers that would enter the two cells would be nearly equal. If the daemon should disturb this statistical equilibrium, he would produce a physically observable effect. This would imply a physical difference between "good" and "bad" photons which we desire to avoid. Under the conditions as described, however, only an individual event is determined by the daemon, and the statistical equilibrium is unaffected. Thus the intervention of the daemon is physically undetectable. That is, the action has occurred strictly according to physical laws, in spite of the fact that the course of the event was not governed by chance but was determined by the whim of the daemon.

The point is that the event under consideration is really an individual act, to which, since it can be performed but once, the laws of statistics do not apply. Whether the switch is opened or the dynamite exploded by the first photon, in either case the experiment is complete. This corresponds closely to human action, considered in light of habit. An experiment involving deliberation can be performed on a person only once; for afterwards his condition is not the same. Habit will now enter into the determination of his action. Thus deliberate actions likewise are individual events, and are not therefore predictable from laws of probability.[12] Faced by the necessity for an individual decision, all one's physiological structure, his environment, and previous history determine what Warren Weaver describes as a "spectrum of action probability," within which "spectrum" it is possible for any action to be chosen. There will be greater probability for certain modes of action than others; but these probabilities do not completely determine the choice of the individual act.

12 At first sight it might seem that such facts as that one can at will place a coin "heads up" a thousand times in succession would constitute a violation of statistics in such a sense as to make physically detectable departures from the chance predictions of physical law. Such a series is, however, a single act in the sense that it is the initial choice to turn up the thousand heads that determines the whole series. Except in so far as habit (a physiological or physical factor) intervenes, when the next choice is made, "heads" and "tails" would be equally probable.

It would be easy to outline a closely parallel scheme whereby consciousness could select the desirable brain current, even though the undesirable one might be equally probable from statistical considerations thus leading to the performance of the desirable act rather than its alternative. It is not necessary to elaborate any particular brain mechanism for performing the selection, for the example just given shows that it is possible to select one of a number of physically possible acts without violating or modifying any physical law. In this way the determination of a man's actions by his will is, I believe, shown to be wholly consistent with the principles of physics.

The situation is then, in brief, such physical laws as the conservation of energy and momentum, the initial conditions and past history, serve to define limits within which action is possible. Within these limits there may be a wide range wherein a man may do as he pleases without violating any physical law. That he actually does as he pleases is a matter of everyday experience. A man's pleasure, in other words consciousness, is thus an additional determining factor which supplements the physical laws in defining his actions.

Perhaps a new form of determinism could be developed in which psychological laws which may fix a man's choice would supplement the physical laws that leave him a certain latitude of action. It is questionable, however, whether anything more than a probable choice could thus be predicted. Psychological laws, like physical laws, may very probably be found to be statistical, and the definite decision would still remain with the individual. But this is not the physicist's problem.

Physically speaking, a pile of stones in a quarry is infinitely more probable than the same stones built into a Taj Mahal, though both are possible. Humanly speaking, it is the wishes of a king, the creative enthusiasm of an architect, and the skilful work of the artisans, all working within the limits of physical law, which determine that the stones must assume the form of a beautiful building, a lasting monument to human love.

Such a solution of the old dilemma of freedom in a world of law means that when the law of causality is replaced by the principle of uncertainty, Socrates' indictment of science as the underminer of morality no longer applies. Man is left by science in control of his own actions within the bounds set by natural law. Moreover, the powerful argument for morality which Pythagoras saw in a world governed by law is emphasized by every advance of science. Instead of removing the foundation of morality, science now presents new reasons why men should discipline their lives, and supplies new means whereby they can make their world more perfect.

Furthermore, our physical laws have acquired a new generality. We have seen that the effectiveness of consciousness in controlling the action of a living organism in no way implies a limitation of the validity of our physical laws as they are now understood. We may justifiably assume that these laws apply equally to living and nonliving matter. Such universal validity could not be claimed for any set of physical laws, such as those of Newton, which involved a strict causality principle, unless human freedom was considered fictitious.

Epicurus, who wished to preserve the effectiveness of purpose, introduced an irregularity into the motion of Democritus' atoms to avoid the consequences of rigid determinism. He was severely criticized, however, by scientists and philosophers alike, for thus departing from the spirit of his master's philosophy.

Kant's avenue of escape from the dilemma was different. Convinced by Newton's successes of the universal validity of strict cause and effect in the physical world (which he calls the "phenomenal" world), he postulated a nonphysical world of "things in themselves." This world is related to the world we know, but the phenomena of nature give no information about it. In this nonphysical world, according to Kant, the "things in themselves" are not bound by causality and a living organism is free. The corresponding physical things as we know them, including our own bodies, follow the strict laws of cause and effect. It seems to be a hollow kind of freedom that is secured in this way, and one is not surprised to find in his *Third Critique of Pure Reason* that Kant himself is dissatisfied with the result and searches for another interpretation of freedom.

In the light of the new quantum physics the situation is reversed. It is now in the physical world, which we observe with our instruments, that things follow statistical instead of exact laws. If we wish to retain any exact relation between cause and effect (as for philosophical satisfaction) it is only in a nonphysical world, regarding which observable phenomena give no information, that the events can be rigidly determined. It is in this nonphysical world that we have supposed thoughts and motives play a determining part, while in the physical world, in which such things pass unnoticed, events appear to follow the laws of chance.

The world around us does not obey exact laws. Does this mean that the foundations of science are being shaken? If we mean by science the organized body of tested truths, such tested truths are eternally reliable. By gaining a more complete knowledge of nature's definite aspects and learning the statistical probability of her uncertain actions we can still use nature as our servant. It seems that some degree of uncertainty, such as the physicist has recently found, is necessary if such nonphysical things as thoughts and motives are to have any relation to the physical world. It is, in short, only because the world in a physical sense is not wholly reliable that it can have any human meaning.

Plato saw man as master of destiny, but an unfortunate twist of his philosophy took from man the tools of science by which that mastery might be attained. Newton found the tools again, but his followers so interpreted his science as to make us lose the vision. It would seem that now at last the way is clear for us, using the tools that science gives, to work with courage and faith for the goal of mastery which Plato saw.

At first men try with magic charm
  To fertilize the earth,
To keep their flocks and herds from harm
  And bring new young to birth.

Then to capricious gods they turn
To save from fire or flood;
Their smoking sacrifices burn
On altars red with blood.

Next bold philosopher and sage
A settled plan decree,
And prove by thought or sacred page
What Nature ought to be.

But Nature smiles—a Sphinx-like smile—
Watching their little day
She waits in patience for a while—
Their plans dissolve away.

Then come those humbler men of heart
With no completed scheme,
Content to play a modest part,
To test, observe, and dream,

Till out of chaos come in sight
Clear fragments of a Whole;
Man, learning ways aright,
Obeying, can control.

The Great Design now glows afar;
But yet its changing scenes
Reveal not what the Pieces are
Nor what the Puzzle means.

And Nature smiles—still unconfessed
  The secret thought she thinks—
Inscrutable she guards unguessed
  The riddle of the Sphinx.

SIR WILLIAM DAMPIER.

III.

INTELLIGENCE IN THE WORLD OF NATURE

Was the eye contrived by blindly moving atoms,
Or the still-listening ear fulfilled with music
By forces without knowledge of sweet sounds?
Are nerves and brain so sensitively fashioned
That they convey these pictures of the world
Into the very substance of our life,
While that from which we came, the Power that made us,
Is drowned in blank unconsciousness of it all?
Does it not from the things we know appear
That there exists a Being, incorporeal, living,
Intelligent, Who in Infinite space,
As in His infinite sensory, perceives
Things in themselves, by His immediate presence
Everywhere?

ALFRED NOYES, "Watchers of the Sky."

PROBABLY most of us would agree that a religion without a God would not in any adequate sense be a religion at all. For is not the very essence of religion the setting up of a satisfactory relationship between man and those higher powers which we usually call God? Anything less than this might be called philosophy, or a system of morals, but hardly religion. Furthermore, for the purposes of religion, a God without intelligence would be as good as no God at all. Thus if religion is to be acceptable to science it is important to examine the hypothesis of an Intelligence working in nature.

The discussion of the evidences for an intelligent God is as old as philosophy itself, and it is not to be expected that anything essentially new will be added in this brief presentation. The need for a Creator to start the universe is still, as has long been true, felt by some scientific men, but not by all. But the argument on the basis of design, though trite, has never been adequately refuted. On the contrary, as we learn more about our world, the probability of its having resulted by chance processes becomes more and more remote, so that few indeed are the scientific men of today who will defend an atheistic attitude.

It is sometimes supposed that the scientific attitude means refusal to accept any hypothesis that has not been proved. This would involve rejection of the idea of an intelligent God until the truth of the hypothesis had been demonstrated. The fact is that almost none of the hypotheses, principles, or laws of science are considered as proved; nor does this destroy their value. It is in fact the very essence of the scientific method that hypotheses are found to be valuable as working bases even though they have not been proved. These are "working hypotheses."

Even such a "well-established" principle as the conservation of energy, which has been found invaluable as a basis for calculations and predictions, has during the last decade been made the subject of new and more searching tests. Some of these it has withstood, regarding others we are not so sure. It is not impossible that the principle will need in some way to be modified. In the meantime, does the physicist refuse to "accept" the principle that energy is conserved? On the contrary, though recognizing that certain modifications may be necessary when the principle is applied to the inner atom, it is continually used with confidence under conditions where its reliability has been tested. Even when unknown fields are being opened up the principle is of value in suggesting what we may expect to find. The physicist thus acquires a great "faith" in such a principle. He can count on it leading him to correct conclusions. Is it proved? No. What if evidence should be found definitely against it? Then it will be necessary to find a modified statement, which will give identical results as applied to the cases where the present principle is valid and yet be extended to include the new facts. This is exactly what was done when Lorentz and Einstein modified Newton's laws of motion to describe satisfactorily objects moving at speeds close to that of light. Faith in a scientific principle is justified when tests have shown that its application leads to correct or at least to useful conclusions. Nevertheless, the true scientist is prepared at any time to accept new evidence which may require that he modify his principle.

So faith in God may be a thoroughly scientific attitude, even though we may be unable to establish the correctness of our belief. Such a faith is presumably based on the experience that the hypothesis of God gives a more reasonable interpretation of the world than any other, and perhaps also, to the religious man, that it helps the thinking associated with his emotional life. If we are scientific, we shall be prepared to accept new evidence. It is possible that such evidence will convince us that our faith that a God exists was wrong. It is much more probable, however, as has nearly always been the case with so-called "revolutions" in science, that the new information will cause us to change in some way our conception of God. The resulting attitude after such a "revolution" in both science and religion is almost inevitably more adequate and satisfying than the earlier view around which the faith was originally formed. The transition usually means an uncomfortable period of storm and stress; but a man is a scientific or religious coward if he is unwilling to brave the storm in the hope of reaching the firmer ground on the other side.

It was at the close of the eighteenth century that the brilliant French mathematician La Place published his famous treatise on Celestial Mechanics, in which he developed his Nebular Hypothesis of the origin of the Solar System. It is said that

Napoleon said to him, "M. La Place, they tell me you have written this large book on the system of the universe, and have never even mentioned its Creator." "I have no need for that hypothesis," replied La Place.[1]

This attitude is typical of the mechanists of the seventeenth to the nineteenth centuries, who were strongly influenced by Newton's discoveries. Where law and universal order are apparent, there God is not needed. It is only in unusual phenomena, such as miracles, that God is concerned. The familiar phenomena of nature require no deistic explanation—they are so self-evident! The advances of science, reducing to the order of law things which have been considered mysterious or the results of special acts of God, have led many people to fear that God will be crowded out of his universe. Thus Auguste Comte considered the religious interpretation as the earliest of three stages, of which the

[1] "*Je n'avais pas besoin de cette hypothèse—la.*" Napoleon, greatly amused, told this reply to Lagrange, who exclaimed, "*Ah! c'est une belle hypothèse; ça explique beaucoup de choses*" Dampier-Whetham, *A History of Science* (1929), p. 193.

final stage, held by thinkers like himself who had put away these primitive views, is the positivistic or "scientific" attitude. When science has done its complete work, he predicted, it will conduct God to the frontier of the universe and bow him out with thanks for his provisional services.

An alternative view of the relation between God and nature was held by the great master of scientific thought, Isaac Newton, whose dynamics these mechanists adopted, but whose philosophy they considered naïve. His views are developed in his masterpiece, the *Principia,* and have been accurately paraphrased by Alfred Noyes:

> Whence arises all this order, this unbroken
>   chain of law . . .
> Whence, but from some divine transcendent
>   Power? . . .
> And Newton, from a height above all worlds an-
>   swered
> And answers still, "This universe
> Exists, and by that one impossible fact
> Declares itself a miracle; postulates
> An infinite Power within itself, a Whole
> Greater than any part, a Unity
> Sustaining all, binding all worlds in one.

'Tis not the lack of links within the chain
From cause to cause, but that the chain exists.
That's the unfathomable mystery,
The one unquestioned miracle that we know,
Implying every attribute of God."

The scientist who recognizes God knows only the God of Newton. To him the God imagined by La Place and Comte is wholly inadequate. He feels that God is in nature, that the orderly ways in which nature works are themselves the manifestations of God's will and purpose. Its laws are his orderly way of working.

Science's Need for Intelligence in Nature

IT will be worth while to examine some of the specific problems with which science is faced that have seemed to indicate an intelligent Power working in the universe. We shall consider one such problem from each of three sciences—physics, astronomy, and biology.

The physicist finds the world built, as far as he can now tell, of a few different elemental units, which he calls protons, electrons, neutrons, and photons. Each one of these particles is, to the best of our knowledge, exactly like every other in its class. From the protons, electrons and neutrons the atoms and molecules are built, and from the molecules, the ordinary things with which we are acquainted. Streams of photons make up rays of light and heat, carrying signals from one atom to another. The problem presents itself of understanding what characteristics these three kinds of particles must have in order that they may be capable of massing themselves together to form a complex and interesting world such as ours.

Suppose we have several great piles of sand, whose grains represent protons, electrons, neutrons, and photons. We are empowered to endow these grains with such properties that they will combine into complicated structures which will show the active characteristics of atoms and molecules and living organisms. What properties shall we give them?

Physicists have tried many sets of properties, which on close examination are found not to work. It is our hope that we shall in due time learn enough of the nature of electrons and neutrons and protons so that we may be able to select suitable characteristics. We feel that we know pretty well how to build the outer atom; but its nucleus still has us baffled. It would seem that we still have a long search ahead of us. Yet from what we have already learned it appears that these properties are of a simple type—mere pushes and pulls, combined with a peculiar ability to appear alternatively as particles or waves. Can it be a matter of chance that protons and photons and electrons have that particular set of characteristics that is necessary for development into a world of infinite variety and life? If so, chance can choose much more wisely than the best scientific minds of today.

Consider a single example. It is well known that the element carbon is capable of entering into a remarkably large variety of chemical combinations. In fact over a hundred thousand carbon compounds are recognized, more than all of those formed by the remaining ninety-one elements. It is this wide range of its chemical possibilities that makes carbon essential to organic life. Any possible "life" without carbon would necessarily be on a much more limited scale, because of the very fact that the chemical versatility of all other elements is much more limited. But why should carbon have these unusual properties? We find that these properties are associated with the fact that the carbon atom has six electrons surrounding its nucleus —each chemical atom has its own number, hydrogen one electron, oxygen eight, lead eighty-two, and so on. Thus, as Eddington has expressed it, if nature had forgotten the number six, life as we know it could not exist.

The reply may be suggested that the number six was unavoidable. True; but it is important also that element number six should be plentiful for our world to have its present interesting form. Had it been as rare as elements 3, 5, 9, or 10 (lithium, boron, fluorine, neon) life would also have necessarily been exceedingly limited. But further, it is clear that chemical versatility, such as is characteristic of carbon, is very rare, and if our electrons and protons had but slightly different properties the chances of finding an abundant chemical element with similar properties would be small.

Innumerable examples of a similar kind might be quoted, indicating that it is only with very special qualities that large numbers of electrons and protons could have organized themselves into anything other than a simple, dead, monotonous world. Can these very special qualities have just "happened"?

As a typical problem in astronomy, we might use the related question of how it happens that a primitive chaos can evolve into systems of galaxies, suns, and planets. For sake of variety, let us consider rather a question now under active debate in astronomical circles, How old is the universe? Ever since the writer of Genesis penned the statement, "In the beginning God created the heavens and the earth," one of the chief philosophical occasions for the postulate of God has been to supply a creator for the world in which we live. On the other hand, many have asked themselves, "Is it not possible that the world may really be eternal and self-continuing?"

Present-day scientific opinion on this point is sharply divided. The prevailing view at the moment seems to be that the universe as we know it had a beginning at a more or less definite time, variously estimated as between a few billion (10^9) and a few million billion years. The discovery of radioactivity carried with it the discovery of a clock by which to measure the earth's age. The end result of radioactive disintegration is lead. If a rock contains ore of the radioactive elements thorium or uranium, there is always lead present also, due to the disintegration of these elements. By determining the ratio of the lead present to the thorium or uranium and knowing the rate at which these elements disintegrate, it is found that the oldest rocks in the earth's crust are about a billion and a half years old, and the oldest rocks showing fossil life are about a billion years old. This would indicate that the earth was formed perhaps a few billion years ago. Dr. J. C. Merriam informs me, however, that even the "archaic" rocks, 1,500,000,000 years old or so, appear to have been at one time similar to the younger sedimentary and igneous rocks which now form most of the earth's surface. That is, the conditions on the earth have not changed much since these very old rocks were first formed. Thus the earth itself might well be several times a billion years old, as far as geological records show.

But how about the sun and the stars and the galaxies into which the stars group themselves? Presumably these must be older than the earth. But as yet no method of estimating their age has appeared which is sufficiently direct to command general acceptance. Jeans has attempted to place an upper limit to the age of the stars by calculating the time required for all of a star's mass to be radiated away in the form of heat and light. It is known that the heat and light radiated from the stars carry with them part of the stars' mass. The sun, for example, radiates itself away at the rate of four million tons per second. Einstein has a theory according to which we can calculate just how much heat each ton of a star's matter can produce as it dissipates itself. Following this argument, Jeans has estimated that the universe of nebulæ and stars could not have been in existence for more than about a million billion years. This estimate is, however, by no means universally accepted. Thus MacMillan, starting from much the same facts as Jeans, reaches the conclusion that the universe has an indefinitely long life. Though each star radiates itself away, MacMillan supposes that the radiant heat (photons) may form again into ordinary matter (protons and electrons) during its long journey through space, and become the material out of which new nebulæ, and thence new stars, will be built. He therefore arrives at a cyclic universe of endless life. Eddington and others have pointed out that such a cyclic universe defies the second law of thermodynamics. According to this law, the universe must continually approach the most probable condition, which would be that of a dead homogeneity. This law Eddington considers to be one of the best established in modern physics. Tolman, however, has recently found that when the principles of general relativity are applied to thermodynamics, such a "heat death" is not necessarily to be anticipated, and he arrives at a cyclic type of universe similar to that of MacMillan. On the other hand Bohr, the great Danish physicist, while retaining the second law of thermodynamics, gives reasons for believing that in the sun's interior the law of the conservation of energy itself may not hold, and that the sun's terrific fires may be burning eternally.

Another aspect of the problem which has recently appeared is the discovery that the very distant nebulæ, which are galaxies similar to our Milky Way but at immense distances, seem to be receding rapidly from the earth. This has led to the hypothesis that in times past the universe was much more concentrated than it now is, the stars being much closer together, and that several billion years ago it "exploded," the stars flying from each other until they should reach their present distribution. The "age" of the universe as we now know it would then be the time required for the stars to move away to their present distances at about the speeds they now possess. This theory has its experimental basis in the observed fact that a given spectral line, such as that due to sodium, is longer in wave-length as observed in these remote nebulæ than as seen in the laboratory or in the nearer stars. The most obvious explanation of this difference is that the remote nebulæ are rapidly running away from us. That such a motion should occur is strongly suggested by the recent forms of relativity theory. Nevertheless, the age of the universe as thus calculated, about ten billion years, is not much older than the known age of the earth, a circumstance which presents a serious difficulty. Thus many astronomers look for an alternative explanation of the shift toward the red of the nebular spectra, and the theory of the expanding universe is by no means generally accepted.

One fact that emerges clearly from these conflicting theories is that we cannot say with any assurance from the existing evidence whether the world is an everlasting system, or whether it has had the comparatively short life of a few thousand million years.

It is interesting to note, however, that many of the defenders of both views have found it difficult to understand the world as other than the expression of the activity of a high Intelligence. Eddington and Jeans and Lemaitre, who have been defending the view that the world is of comparatively recent origin have taken definitely theistic attitudes. To Jeans the idea of God as a great Mathematician[2] has been attractive, seeing as he does the elegant way in which the world processes can be described by mathematical formulas. Eddington, whose expressions are less narrowly confined by his mathematical reasoning, sees our physical universe as the product of a Creator[3] with a far-reaching purpose that we can only dimly discern. On the other hand, perhaps the best defense that has been made of the eternal cyclic universe is that of Northrop[4] who postulates a "macroscopic atom," which is really the God of the Universe, which by intelligent choice guides nature along directed lines, and thus voids the working of

[2] J H. Jeans, *The Mysterious Universe* (1930), p. 144.
[3] A. S. Eddington, *The Nature of the Physical World* (1928).
[4] F. S. C. Northrop, *Science and First Principles* (1931).

the second law of thermodynamics. Such examples are typical as indicating how efforts to interpret these ultimate facts of nature suggest to many who study them the hypothesis of an Intelligence working in the world.

For our biological problem, it will be of interest to consider certain aspects of evolution. We are all familiar with the evolutionary description of how life has developed on this planet. On some primordial shore, where stagnant waters were warmed by the rays of the sun and the necessary complex chemical compounds had gradually formed, perhaps under the stimulus of ultra-violet light, we imagine the first living cells took form and reproduced their kind. These simple, single-celled organisms formed groups, and differentiation of function appeared, making multicellular organisms that were more adaptable to their environment. There was a gradual separation into the two great groups of plants and animals. The latter organisms are self-moving and search for their food. In them arises the beginning of purpose and initiative. Sly cunning, maternal love, and reason take their places as this evolution carries on through the higher animals to man.

Recent spokesmen for biology have emphasized two important aspects of this evolutionary process. The first is that at each new stage novelties appear. These are new qualities or powers which cannot be inferred by adding together the qualities of a lower stage of evolution. Among the novelties that thus emerge are life itself, which could not be inferred from knowledge of the chemical elements; and reason, which would not be inferred from the actions of an amœba. This fact is well described by the name given to the phenomenon, "emergent evolution."

Many recent biologists, especially the paleontologists who have been most directly concerned with tracing the evolutionary processes, find also that variations of species do not go like arrows shot at random in all directions, but frequently go in specific directions for many generations. This is contrary to Darwin's hypothesis of random spontaneous variations. Evolution, that is, reaches a certain stage by following a direct course instead of by the devious route of chance variations. This phenomenon is known as "orthogenesis." It is one of the facts which leads Northrop to postulate his "macroscopic atom," the world as an organized, intelligent unit, which directs its own processes to desirable ends.

We need hardly point out that evolution is in itself no explanation of these remarkable processes; the theory of evolution is merely the description of how these processes occur. It is, however, difficult to avoid an interpretation which sees underlying these evolutionary processes an intelligent power, directing it with some great purpose.

The cumulative effect of many lines of evidence such as we have been considering has been described by one writer as "God without Religion." He sees science accepting the hypothesis of a supreme Intelligence working through nature's processes as the only satisfactory method of accounting for the remarkable world in which we find ourselves. But this Intelligence does things on so grand a scale that it would be foolish to suppose it concerned with the welfare of any individual. On this view a religion based on an intimate relationship between any man and this supreme Intelligence is unjustifiable. Let us therefore examine more closely the question of God's relation to man.

IV.

MAN'S PLACE IN GOD'S WORLD

What is all science then
But pure religion, seeking everywhere
The true commandments, and through many forms
The eternal power that binds all worlds in one?
It is man's age-long struggle to draw near
His Maker, learn His thoughts, discern His law—
A boundless task, in whose infinitude,
As in the unfolding light and law of love,
Abides our hope, and our eternal joy.

Isaac Newton, as paraphrased by
Alfred Noyes in "Watchers of the Sky."

IN Milton's *Paradise Lost* the poet pictures a world peopled with angels and devils and men, all of whom, though free to follow their own desires, are ruled by a mighty God. Man's sole responsibility to his Creator is to obey his explicit commands regarding keeping Paradise in order, and to abstain from the fruit of the tree of knowledge. Man is but one of his Creator's many interests; yet his disobedience against God's commands is of great significance in changing the course of Heaven's history.

As viewed by certain exponents of modern science, man is merely the most intelligent of a large group of organisms, evolved by the automatic working of the natural laws of chemistry and evolution, that have infected the crust of one of the minor planets of one of the smaller stars of one of millions of galaxies. His actions are of significance to no one but himself and his fellow animals on this planet. What matter even if by mutual consent mankind destroy itself, as for example by a suicidal war? It would be merely the closing act of a side show that is of negligible importance compared with the rest of the great celestial circus.

The fundamental answer to this materialistic view of man's place in nature is that it confuses mere physical size with value. If man is rated as insignificant, who is the judge that considers him of so little value? Obviously, if we speak of value, we mean value as judged by some intelligent being or group of beings—otherwise the term is meaningless. Who then will evaluate man?

In his own eyes there can be no question but that man himself is of supreme importance. This idea may be considered as an aspect of self-preservation, and it is fundamental to the welfare of the race. If we want any more ultimate basis of value, we must refer to some superior intelligence, that is to man's value in the sight of God. Of how great import may we reasonably assume an intelligent God of the Universe to consider man?

As I write this I have been visiting a great grain elevator in company with the engineer responsible for its design and construction. Heavy freight cars are picked up as toys, and tipped on end to pour out their load of wheat onto the rapidly moving conveyor belts. Powerful machines winnow and clean the grain and sort it into the appropriate bins. Other conveyors carry the wheat to the long series of loading spouts, where it is poured into the hold of a ship waiting to carry the precious cargo across the ocean. Where is the important thing in this great structure? Is it the mighty mass of steel and concrete, covering acres of ground and rising hundreds of feet into the sky? Is it the powerful motors that handle the cars and carry the grain where it is wanted? Of what value would these be were it not for my companion whose constructive thought it represents, and who now checks it over to be sure the great system functions as was planned? A lifeless mass of stone and steel were it not for the handful of men whose will it obeys!

Or, again, is a house of greater value to its owner than the family it protects?

For the importance of anything depends upon the interests of the one who judges. Is man of less significance than the stars? Ask a mother if she would trade her newborn babe for the brightest star in the heavens. Even to the astronomers, if the child happens to be a Newton, he would be worth many galaxies of stars. Who then is to say that man is an object of indifference to God? Is it not reasonable to suppose that to an intelligent Creator intelligent creatures may be of especial interest?

Intelligent Life in the Universe

LET us inquire whether the intelligent life that we find on our planet is distinctive, or whether there may be something like it on millions of other planets distributed throughout the universe. Life as we know it requires conditions under which a wide variety of chemical processes can occur. It appears that these processes necessarily include carbon and its compounds, which are stable under a hundred degrees Centigrade, and whose more important reactions occur only above zero degrees Centigrade. Water is also necessary. It may be supposed that other substances, such as silicon compounds or carbon dioxide might lead to life of an entirely different kind. While this may be admitted, the only kind of life we know requires very complex chemical processes, and, as has been noted above, the reactions of carbon compounds in the range of temperatures indicated are far more varied than those of any other compounds in any other temperature range. Any other possible form of life must therefore be greatly restricted as compared with that of the type found on earth.

Modern stellar spectroscopy indicates that the chemical elements with which we are acquainted are probably present in somewhat the same proportions throughout the whole universe. Yet it is difficult to match elsewhere our conditions of temperature. In the solar system, the earth, Mars, Venus, and the moon are the only bodies on which the temperature range is suitable for life. The moon, however, has no water, and no detectable atmosphere, which makes any highly organized life impossible. Direct observation with telescopes also reveals no sign of vegetation. All indications are that the moon has never been the abode of life. Likewise Venus, though at first promising, seems to be sterile. This planet has an atmosphere, and its temperature—at least in parts of the planet—comes within our desired range. What used to be considered clouds have recently, however, been interpreted by Dr. Slipher as dust storms. Spectroscopic studies reveal large amounts of carbon dioxide in its atmosphere, but no water vapor or oxygen.

We must digress here for a moment to consider the probable origin of our own atmosphere. Its constituents essential to life are nitrogen, oxygen, water vapor, and carbon dioxide. As far as we know, the small amounts of noble gases, argon and its cogeners, take no part in vital processes. In a planet having an excess of iron and other metallic materials, it is impossible that free oxygen can have been an initial constituent of the atmosphere. There is sufficient coal in the ground to warrant the assumption that the oxygen in our atmosphere has come from growing vegetation, which has decomposed most of our original atmosphere of carbon dioxide into free oxygen and carboniferous plants. It is not unlikely that the nitrogen in the air is the remainder of a denser blanket that may have originally formed our atmosphere. Professor H. N. Russell has recently called my attention to the fact that the oxygen in the atmosphere is being continually spent in completing the oxidation of the iron compounds in the soil. Thus red clay and rock, which owe their color to completely oxidized iron, are found only in layers that have been at the earth's surface for long periods of time. There still remains much partially oxidized iron in the form of green clay, black magnetite, etc., which, as it becomes oxidized, removes oxygen permanently from circulation. It is only under the most exceptional circumstances, such as lightning flashes, that nitrogen can be used up in a similar way. It is therefore probable that the oxygen now in our atmosphere represents only a small fraction of that which has been freed by vegetable growth.

One aspect of such chemical considerations is that it reveals life as possible only during a certain stage of a planet's existence. Plant life, which depends upon carbon dioxide, can start early in the planet's history, but can continue only until the carbon dioxide has been used. At present only about one part in a thousand of the earth's atmosphere is carbon dioxide—less than one per cent as much as in the atmosphere of Venus. Probably volcanoes and similar processes are throwing carbon dioxide into the air about as fast as growing vegetation uses it up; but eventually after some billions of years as the earth grows geologically old this source must gradually fail, and vegetable life will fade into extinction. Similarly animal life, dependent upon oxygen, will also approach hard times as the earth reabsorbs the supply in the atmosphere.

From this review of geochemistry it will be evident that the presence of large quantities of carbon dioxide with no detectable free oxygen in the atmosphere of Venus shows that our fair neighbor has never been the home of life as it is known upon earth.

Regarding Mars the evidence is divided. Coblentz' temperature measurements show its climate to be temperate. Dr. Dunham with his spectroscope at Mt. Wilson concludes that its atmosphere contains less than one thousandth as much oxygen as does our earth's, and he likewise finds no detectable spectroscopic evidence of water vapor. The polar caps of Mars, which shrink in the summer and grow in the winter, together with Slipher's photographs of clouds near the polar caps and on the morning and evening terminators give clear evidence however of water, though its vapor pressure is doubtless low. Similarly the most evident interpretation of the red color of Mars is that its surface contains large quantities of red oxide of iron. From the discussion in the preceding paragraphs it will be seen that this would mean the presence, at some time in its history, of free oxygen in the atmosphere and hence of vegetable life. More positively, seasonal changes of color are found to occur over large areas of Mars, just as would be expected to accompany the growth of vegetation, and no adequate alternative interpretation of their cause has been proposed. Among the regions where these seasonal changes occur are the curious "canals," whose interpretation remains an enigma.

Speaking not as an astronomer, but as one who has long followed these astronomical studies of the planets with interest, I may say that this evidence has led me to base my own thinking on the assumption that Mars is the abode of vegetation, with no sufficient evidence on which to form an opinion regarding animal or intelligent life. On the contrary, the known facts rule out to my own satisfaction the possibility of life elsewhere in the solar system than on Mars and the earth.

A very important aspect of the evidence of vegetation on Mars is that it supports the view that if the conditions of temperature, atmosphere, light, etc., are right, life will appear on a planet. If our only evidence were the single example of the earth, our inability as yet to produce life in the laboratory might reasonably suggest that life here is due to some remarkable accident whose chance of reoccurring elsewhere would be very small. Such a view would be greatly strengthened if we found good evidence that in the seemingly favorable cases of Mars and Venus and the moon life did not exist. The finding of a second planet where life occurs strongly supports the alternative assumption that life such as we find on earth represents the natural course of events, and may be expected to occur in a similar manner wherever the necessary conditions are duplicated. At the same time, life's failure to get a start even in such cases as the moon and Venus, where certain of the conditions are favorable, warns us that the necessary conditions are very narrowly defined.

At first sight this survey of the solar system would suggest that we should probably find throughout the universe a very large number of planets inhabited by intelligent beings. More careful consideration, however, throws doubt on this conclusion. It is clear that the stars, which are intensely hot like our sun, cannot be the abode of life. There is reason also for believing that these stars represent the natural divisions of cosmic matter. According to Jeans, larger masses should under mechanical forces divide themselves into units of stellar size, and if smaller masses occur, they should soon become cold by radiation of their initial heat. Thus the only places suitable for the development of life would be planets that are kept warm over a long period of time by radiation from a neighboring sun. Our best evidence at present indicates, however, that such a system of a sun with associated planets can only be produced when two stars approach so close to each other that their mutual tidal action draws out a part of each to form the planetary system. Such encounters between stars, because of the immense distances between them, are exceedingly rare. Estimating the age of our universe at some ten million million years, Eddington in fact calculates that only perhaps one in a hundred million stars will during that time have suffered an encounter capable of resulting in such a system of planets. If the more recent view of an expanding universe is correct, a few billion years ago the stars must have been much closer together than they are now, but the time during which collisions may have occurred is likewise much shorter. It thus becomes apparent that planetary systems are probably the rare exception rather than the rule.

If moreover we are interested in where intelligent life may be found at the present time, we are further limited. Some planetary systems may have been formed so long ago that the conditions suitable for highly developed life have ceased to exist. In others evolution will not have been carried to a sufficient stage. Thus it will probably be near only a very small fraction indeed of the stars that surround us that life similar to that which we enjoy exists at the present time.

Such considerations have led Eddington to state:

> I do not think that the whole purpose of Creation has been staked on the one planet where we live; and in the long run we cannot deem ourselves the only race that has been or will be gifted with the mystery of consciousness. But I feel inclined to claim that *at the present time* our race is supreme; and not one of the profusion of stars in their myriad clusters looks down on scenes comparable to those which are passing beneath the rays of the sun.[1]

Some astronomers do not agree with Eddington in this, but feel that conditions like those on the earth are much more common. I am myself persuaded by Eddington's evidence. We need not think that if human life fails to achieve its great goal on earth that it is nature's last chance. Yet in all probability, within our universe such chances are quite limited in number.

[1] A. S. Eddington, *The Nature of the Physical World* (1928), p. 178. His chapter on "Man's Place in the World of Nature" deals with this question in much greater detail

The position might be taken that this rarity of life means that life is of minor consequence in nature's scheme. One might as well argue from the fact that only one maple seed in a million grows to a great tree in the forest that the growth of trees is only a minor interest in the life of the maple seed. Just as truly as the maple seed will sprout and grow where the conditions are right, so our knowledge of the earth and Mars suggests that wherever a planet exists under the right conditions life will appear.

Recently I visited Sequoia National Park, and saw there a group of giant redwoods. Among them was one known as General Sherman, said to be the largest tree in the world, and a group of some hundreds of lesser giants, each of which has been growing for thousands of years. Each tree is a monument that it would require an age to replace and our government has rightly chosen to spare them from the woodman's ax. If by some disaster one tree is destroyed, nature has yet others which may develop to their full majesty. But the number of trees is limited, and to those who love the trees it is of vital interest that each healthy one which has a promising location be given a full opportunity to grow.

Is not the life of man on earth similar to that of one of these great trees? No doubt there are or will be other places where similar or perhaps higher types of life may be developed. But there is reason to believe that we may occupy at present the highest position in the universe with respect to intelligent life. Does it seem then too bold to assume that the intelligent Creator, whose existence as we have seen is by far the most reasonable basis for accounting for our world, should take an active interest in the welfare of the uniquely intelligent beings he has created on our earth? The remarkable course of evolution, leading as it has against tremendous odds to organisms with the modicum of intelligence that we possess, really seems to point in that direction.

Is God Friendly toward Man?

LET us for a moment forget our evidence for an intelligent God, and consider the world about us as an impersonal set of objects, in which we find forces at work according to certain laws—a world that is a vast machine. Our study of the laws of nature emphasizes the fact that these laws are immutable; but when we begin to understand them, we are able to turn them to our service. As was perhaps first clearly seen by Pythagoras, if we learn these laws and live in accord with nature's rules, we and our fellow men have a fuller and a happier life.

In fact this lesson of the need for knowledge of the truth and for the willingness to adjust our lives to this truth is, it seems to me, the great contribution of science to humanity. Guided by the truths of physics and chemistry, the inventor and the engineer have freed us from much of the slavery of physical drudgery. Medical science has given us longer lives and has gone far in freeing us from disease and pain. Seeing these successes of science as applied to other aspects of life, men willingly control their habits in accord with the laws of hygiene, and a healthier world results. It gradually becomes recognized that human relations are also subject to natural laws. These form the fundamental basis of morality. Since the days of Pythagoras it has been recognized that a world of law implies a life of self-discipline if that life is to reach its highest development. Thus in an era when many old conventions become outworn, the clear teaching of science is of especial value: If man will learn the truth and abide by it, that truth will make him free.

From the standpoint of evolution, all of our effort to learn the laws of nature and use them to our advantage is an aspect of an organism adapting itself to its environment. A species can thrive only in so far as it is successful in making this adaptation. Biologically speaking, the good man is he who has well adapted himself; he is also the one who will presumably find life most worth living. With regard to such adaptability, man holds a unique place among mammals. Physically his body is very versatile, and his ingenious brain enables him artificially to mold his surroundings to fit his needs far better than can any other animal.

From the observed uniformity and universal applicability of nature's laws, it would be quite unreasonable to suppose that the world plays favorites by showing partiality toward man. Rather we find that the laws of nature are such that, under the conditions existing on earth, a group of living organisms, of which man stands foremost in intellectual development, evolve as a matter of course. As a part of this evolution, his physical adaptability and reasoning powers have undoubtedly arisen through the strict working of natural law. According to this law it is clear that hardships have had to be surmounted. In the age-long struggle with other animals, cunning and craft have developed. To gain needed shelter and food, inventiveness has been at a premium. In order to live in satisfactory relations with other men, a conscience has evolved. At each stage, however, there has been tragic, apparently ruthless, suffering. This has been nature's method of forcing slowly developing humanity to search for and follow the better way. It would be hard to imagine a process for achieving adaptation to environment that would be more certainly effective than the one we see now working in nature. With regard to our distinctively human characteristics we are, however, clearly in the early stages of evolution. It would be a gross understatement to claim that with regard to such attributes as clarity of reason, appreciation of beauty, or consideration of our fellows, our remote descendants may be expected to excel us as greatly as we are in advance of the Java ape-man.

Nevertheless, whatever may be the method employed, the result has been that when we learn nature's laws and school ourselves to obey them, we can turn them to our advantage. That is, these laws are friendly to a well-adapted organism. Is nature friendly to us? Assuredly, if we will learn her laws and adapt our lives accordingly. If we do not, she may become our merciless enemy. Such is the stern yet kindly dictum which science has to offer.

Two Old Testament statements embody the same idea in deistic terms: "All things work together for good for him who serves the Lord," is the exact parallel of nature's laws that are friendly to the well-adapted organism. On the other hand, nature's ruthless attitude toward the man who will not so adapt himself is accurately caught in the proverb, "The wages of sin is death."

Coming back then to the view that the laws of nature are the method in which our intelligent God works, we must believe that His attitude toward us is revealed by the way nature treats us. Is He friendly? Yes, if we learn and obey His laws. But more than this: We find that we are able to adapt our environment to our needs. In fact, we are masters of the plant and animal life on the earth, and have in our hands the means even of controlling to large extent the direction of our own evolution. Up to the dawn of social conscience, which Breasted places as about four thousand years ago,[2] God held in His own hands the whole responsibility for evolution of life upon this planet. Gradually this responsibility is being shifted to our shoulders. As science advances, it

[2] J. H. Breasted, *The Dawn of Conscience* (1933).

seems inevitable that this transfer of authority will approach completeness. Considering the many obvious errors that we are making we may be thankful that we do not yet have complete control. Yet who can fail to respond to the opportunity and challenge that are before us of working with the God of the Universe in carrying through the final stages of making this a suitable world and ourselves a suitable race for what is perhaps the supreme position of intelligent life in His world!

Science can thus have no quarrel with a religion which postulates a God to whom men are as His children. It is possible to see the whole great drama of evolution as moving toward the goal of the making of persons, with free, intelligent wills, capable of learning nature's laws, of seeing dimly God's purpose in nature, and of working with him to make that purpose effective. A group of leading American scientific men in fact recently drew up a statement expressing just such a view:

It is a sublime conception of God which is furnished by science, and one wholly consonant with the highest ideals of religion, when it represents Him as revealed through countless ages in the development of the earth as an abode for man, and in the age-long inbreathing of life into its constituent matter, culminating in man with his spiritual nature and all his God-like powers.

Is God Good?

THERE are certain theological difficulties raised by the view of the relationship between God and man which has just been developed. These I am in no position to discuss with authority. They should, however, be mentioned so that those better qualified may see them as viewed in the light of a scientific approach.

The first is God's undoubted responsibility for permitting evil to be present in the world, if our view is correct that the laws of nature represent His mode of action. There seems no avoidance of the conclusion that if we ascribe to God the beauties of the world, we must likewise assume that He has ordained the vilest crimes. This point has been forcibly presented by Bishop Barnes in his recent book, *Scientific Theory and Religion,* with the conclusion:

For some unknown reason He permitted death, disease, struggle, the instincts which have led to selfishness and lust in man, because He willed that higher moral, intellectual and emotional development which in man is such an unexpected outcome of the process.[3]

It would indeed seem that from the very nature of the evolutionary method such evils must be present in order that man's moral character shall develop. But what shall we say about God's character? Is he nonmoral? It will be seen in the next chapter that the effort to reconcile this evil in God's world with the idea of his goodness leads to one of the classical arguments for immortality.

The second problem is that of God's mercy toward men, so confidently taught by Jesus. There appears but little mercy in the severe discipline by which the mills of the gods grind out organisms adapted to their environment. The description of nature as red of tooth and claw describes only too well man's relations with man as well as the life of animals. Where then is God's mercy?

[3] Pp. 520–522.

My impression is that this mercy is very real, but is to be found in the psychological rather than the physical realm. The knowledge that one has done his best even though in vain, the recognition that both God and our fellow men know the limitations and frailties of our human nature and do not expect of us more than our strength permits, these protect us from the too keen cutting edge of conscience. Here it is that a sane well-balanced religion offers the solace for which men yearn.

Striving for a More Perfect World

IT is an inspiring setting in which we thus find ourselves. We recognize the greatness of the program of nature which is unfolding before us, and feel that we are a vital part of a great enterprise in which a mighty Intelligence is working out His hidden plan. In our hands we hold the control of the conditions of life on this planet. If indeed the creation of intelligent persons is a major objective of the Creator of the Universe, and if, as we have reason to surmise, mankind is now his highest development in this direction, the opportunity and responsibility of working as God's partners in his great task are almost overwhelming. What nobler ambition can one have than to coöperate with his Maker in bringing about a better world in which we live?

To Milton, the best for which man could hope was a return to the golden age of life like that in Paradise before the Fall. We now see ahead of us the possibility of attaining heights of development far above those of the past and the present. When we view men's actions in the light of science we are thus presented with a new hope. Loyalty to our Maker, who has given us the ability, opportunity, and responsibility to mold our lives and our world according to a more perfect pattern cannot but inspire us to work with him heart and soul toward this great end.

When I consider the heavens, the work of Thy fingers,
The sun and the moon and the stars which Thou has ordained,
Though man be as dust, I know Thou art mindful of him;
And, through Thy law, Thy light still visiteth him.

V.

DEATH, OR LIFE ETERNAL?

In my Father's house are many mansions: if it were not so, I would have told you. I go to prepare a place for you. And if I prepare a place for you, I will come again and receive you unto myself; that where I am, there ye may be also. And whither I go ye know, and the way ye know.

JESUS, as quoted in John xiv. 2–4.

SCIENCE speaks much less clearly on the question of immortality than on the related one of the existence of an order and a supreme Intelligence in nature. A man trained in the school of science has a deep-seated reluctance to present evidence which can only be considered as suggestive. Yet many who profess to speak for science have drawn the definite conclusion that death is the end of all. It takes but little investigation to find that this faith in the completeness of physical death is usually based upon an uncritical acceptance of a common sense realism, similar to that which accepts a brick as the hard, heavy, red object that can be held in the hands. Just as a more careful examination shows the brick to consist of a group of molecules, atoms, and electrons—a complex system of electrical fields wholly different from the common sense picture—so the "obviousness" of death is found to disappear when more closely studied. Though it is true that science presents no weighty evidence for life eternal, it is only fair to point out also that science has found no cogent reason for supposing that what is of importance in a man can be buried in a grave. The truth is that science cannot supply a definite answer to this question. Immortality relates to an aspect of life which is not physical, that is, which cannot be detected and measured by any instrument, and to which the application of the laws of science can at best be only a well-considered guess.

If one is to have either a positive faith in a future life or a conviction that death is the end, such beliefs must, it seems to me, be based upon religious, moral, or philosophical grounds rather than upon scientific reasoning. It is primarily to clear the way for such metaphysical thinking that it seems desirable to consider certain scientific aspects of death. Few of us living in the present age would accept a doctrine which is demonstrably contrary to scientific fact or to the spirit of scientific thought. On the other hand our lives would be exceedingly narrow if we based our thoughts and actions solely upon facts that can be subjected to scientific tests. Science, that is, erects a foundation on which our emotional and religious life, if it is to be stable, must be built. The strength and form of the foundation, however, by no means determine the architectural merit of the structure that is to be erected. If a belief in immortality is found to be of value to man, it will not be because of any scientific basis on which the belief rests, but because certain important ideals toward which men are striving can be attained only by a more complete life than is possible in the flesh.

In Christianity, Mohammedanism, and modern Judaism, the doctrine of immortality has played an important part. The older Jewish teaching had little to say on the question, and future life was included in Buddhism only after it had begun to degenerate. The concept of immortality thus occupies by no means as fundamental a place in religious thinking as do man's ability to determine his own actions and his recognition of a supreme Intelligence in nature. Many philosophical as well as religious thinkers have feared belief in immortality since it would tend to reduce the importance of making the best of the life which we are now living. On this basis men have too often been encouraged to overlook the evils that lie about them, with the hope of "a better world to come." Others, on the contrary, have seen in the permanence of personality a powerful reason why a man should develop his own personality to the utmost in order that it should be worth preserving.[1] Thus a belief in immortality can be used either to the detriment or to the advantage of the life of a person or a community according to the kind of relation which the future life is supposed to bear to the present one.

Immortality is a word with such a variety of connotations that it will be desir-

[1] This attitude is effectively developed for example in J. Y. Simpson's excellent book, *Man, and the Attainment of Immortality* (1922)

able to consider briefly some of its aspects regarding which there will be general agreement. No one doubts the influence of a great man's life after he has gone. The ideas of the discoverer of the use of fire are of permanent value. His "spirit" thus lives forever though his name may be all but forgotten in a legend of Prometheus. The thoughts and actions of Washington and Lincoln intimately affect the present course of American life. Recognizing the persistence of such influence, we sometimes refer to the "immortals" as those great men of history who have permanently affected the direction of civilization. The hope of attaining such immortality is one of the most powerful driving motives of the world's leaders. We all, in fact, share with George Eliot the longing:

O, may I join the choir invisible
Of those immortal dead who live again
In minds made better by their presence: live
In pulses stirred to generosity
In deeds of daring rectitude, in scorn
For miserable aims that end with self,
In thoughts sublime that pierce the night like stars,

And with their mild persistence urge man's
search
To vaster issues.

To a greater or less extent, for good or evil, all of us must have a certain degree of such continuous life.

Similarly, there is a very real biological sense in which life is eternal. Though each person, or to be more general each organism dies, the race or species lives on unless some world-wide catastrophe occurs which makes it extinct. In his recent book, *The Universe About Us,* Sir James Jeans assigns a million million years as a reasonable life expectancy for the human race on earth. Though a million million years may not, strictly speaking, be life eternal, it is probably as long a life as most of us want.

The biological center of life is the germ cell, and this, with divisions and subdivisions, grows and lives forever. What the fruit of the apple is to the seed, the body of man is to his germ cell. The apple may decay, but the seed grows into a new tree, which flowers and begets new seeds. The fruit and the tree will die, but there is eternal continuity of life in the cells which develop from seed to tree to flower to seed, over and over again. It is thus because we concentrate our attention upon the tree or the fruit that we say the end of life is death. These are merely the outer wrappings, the hull which surrounds the living germ. Biologically speaking, life, whether it be of an apple seed or of the germ cells of man, is essentially continuous and eternal.

"But," you say, "that is not the kind of eternal life in which I am primarily interested. My body may be merely the hull that surrounds the living germ; but what will happen to me when the hull decays?"

Beyond this point we must cease to speak with assurance. For when you ask, "What will happen to me," you are concerned not with your body but with your consciousness, mind, or soul, however you may choose to call it, which is not material, and regarding which science offers no objective data. Direct observations can be made of the actions of the body, and for the body death is found to be the inevitable end. Our only knowledge of the state of consciousness of others is, however, that which can be inferred from their actions, as interpreted in terms of our own state of consciousness when we act in a similar manner. Since we have not experienced physical death, our idea of what happens to the consciousness associated with an organism at death can be only a reasoned guess, based upon some assumption about the relation between body and mind. In order to test whether such a guess is correct, it would be necessary to receive an authentic and reliable statement from one who has experienced physical death. Lacking such data, any affirmation regarding what happens to "me" cannot carry the assurance of the tested truths of science. At best such an affirmation is a kind of extrapolation far beyond the region of observational test. Even in such a relatively exact science as physics it is a rare theory whose predictions can thus be extrapolated with confidence.

The Conflicting Evidence of Science

LET us examine, however, certain of the hypotheses regarding the relationship between body and mind which have been found useful, and follow out their consequences regarding consciousness after death. First there is the materialistic hypothesis used by certain psychologists, according to which thought is a function of the brain. Every sensation, every idea that we have, even every decision we make is a consequence of some action occurring in the brain. On this view it is obvious that destruction of the brain must carry with it the destruction of consciousness.

This hypothesis has been adopted primarily in order to simplify the problem of behavior by reducing it to a set of mechanical laws. If thought is a by-product of some molecular change in the brain, and if these molecular changes follow definite physical laws, there will be a straightforward sequence of molecular changes starting with the initial stimulus and ending with the final action of the organism. Thoughts may be associated with these various changes, but they cannot alter the end result, for this is determined by the physical laws which govern the molecular actions. The problem of man's behavior is thus simplified by reducing him to an automaton.

Chapter II gives in some detail my reasons for believing that this simplified behavior fails as a complete description of our actions. In some reflex actions and habitual acts we may behave as automata; but where deliberation occurs we feel that we choose our own course. In fact, a certain freedom of choice may, it seems to me, be considered as an experimental fact with which we must reconcile our theories. Because the mechanist's basic hypothesis leaves no room for such freedom, I see no alternative other than to reject the hypothesis as inadequate.

On the other hand, if freedom of choice is admitted, it follows by the same line of reasoning that one's thoughts are not wholly the result of molecular reactions determined by physical laws. For if they were, one's thoughts would be fixed by the physical conditions, and his choice would be made for him. Thus, if there is freedom, there must be at least some thinking possible independent of any corresponding physical change in the brain. On such a view it is no longer impossible that consciousness may persist after the brain is destroyed.

That there is a close correlation between the brain's activity and mental processes is, however, evident. Such phenomena as intoxication, anæsthesia, delirium, and so on, show an intimate connection between the condition of a man's brain and his state of mind. It is tempting likewise to extrapolate the declining mental powers with advancing disease or old age to mean blank unconsciousness in death.

The problem of the connection between mind and matter is one regarding which all our efforts at solution have been baffled. Modern psychology dislikes the idea of a soul or spirit separable from the body. Certainly in a living organism, body and life cannot be separated. Similarly, if I understand my psychology aright, it is commonly supposed that consciousness is not a separable element, but an essential part of the organism. All throughout its evolution, increased complexity of function has been accompanied in some mysterious way by the development of consciousness. Following this view, Bishop Barnes contends "that concurrent psychical and physical phenomena are two aspects of a single process of change. . . . Man's whole mental and spiritual nature is conditioned by his physical nature and its pathological states, no mental or spiritual movement taking place without a concomitant physical movement."[2] On the other hand, perhaps all psychologists would admit with William James that "it has not been proved, and it seems unprovable, that the actual body is the adequate cause and not a purely contingent condition of our spiritual life."

An examination of the evidence in fact shows that the correspondence between brain activity and consciousness is not as close as is frequently supposed. Thus my colleague Professor Lashley has pointed out that both in animals and man a large portion of the brain may be damaged, or even removed, without destroying consciousness or seriously disturbing the men-

[2] E. W. Barnes, *Scientific Theory and Religion* (1934), p. 636.

tal processes. On the other hand, such a relatively minor disturbance as a tap on the skull may, so far as we can tell, completely destroy consciousness for a considerable period of time. Moreover, Bergson has given what seems to be convincing evidence for his statement that "there is infinitely more in a human consciousness than in a corresponding brain," and that "the mind overflows the brain on all sides, and cerebral activity corresponds only to a very small part of mental activity."

It was in part from such considerations that William James was led to reject the view that thought is produced by the brain in favor of the hypothesis that the brain transmits the thought to the body, where the appropriate action occurs. On this view the brain would correspond to the detecting tube of a radio receiver, without which no music can be received. Stopping the sound by destroying the tube does not imply the destruction of the musician whose song is being carried by the ether waves. Such a view of the relation between thought and brain accounts satisfactorily for the observed parallelism between the two, and yet leaves room for the great diversity of the thought processes. James recognizes that during life thought needs brain for its organ of expression; but this does not exclude the possibility of a condition in which thought is independent of brain. He quotes approvingly Kant's statement:

> The death of the body may indeed be the end of the sensational use of our mind, but *only the beginning* of the intellectual use. The body would thus not be the cause of our thinking, but merely a condition restrictive thereof, and, although essential to our sensuous and animal consciousness, it may be regarded as an impeder of our pure spiritual life.

That consciousness must die with the body is then logically required only if we adopt the mechanistic hypothesis that a definite thought is the result of an equally definite physical change in the brain. The seeming fact of free will makes this assumption appear to me highly improbable. It seems rather that the fact of free will demands that our thinking shall be partially independent of brain activity, a conclusion which suggests, though of course does not prove, the possibility of consciousness after death.

Attempts To Get Direct Evidence

VARIOUS societies for psychical research have made careful studies of the evidence which the spiritualists have accumulated, which purport to show the survival of intelligent "spirits" after death. Because of the vast amount of trickery and dishonesty practiced by those who have supplied the evidence, it is very difficult to convince a scientific investigator that the data obtained are authentic and reliable. We base our body of scientific knowledge upon facts which any normal person can verify for himself, if he will go through the necessary training and use the required apparatus. The results of spiritualism do not fall within this category. They are not reproducible, and are accessible only to certain persons, such as mediums, having supernormal powers. I gladly admit that the evidence which spiritualists have to offer may be worthy of serious study. I cannot, however, consider their data as scientific in the usual sense, and for our present purpose it would perhaps be of little value to consider the attempts to obtain such information.

What might appear to be reliable, first-hand evidence regarding the persistence of consciousness after death comes, however, from the experience of those who have been revived after some accident. In the *Atlantic Monthly* some years ago appeared an article by one who claimed to have died nine times. He had been drowned; had fallen down an elevator shaft and been stunned into unconsciousness; had died a lingering death on the battlefield, later to be revived; had been knocked out by a blow on the head; had been anæsthetized; and so on. This emulator of the cat described the experience of death as "the mere cessation of consciousness—nothing more."

Though the directness of such evidence makes it carry great weight it is nevertheless questionable. I recall one evening when my brother came home from playing football and sat down to dinner. Soon he began asking us, "What's the matter?" He had received a blow on the head, resulting in a lapse of memory. Five minutes after each explanation would come back the question, "What's the matter?" He recognized everyone in the room, talked rationally, and played familiar tunes on his mandolin. By every test he was perfectly conscious; only his memory was very short. At about ten o'clock the following morning his thoughts returned to their normal channels. Now he remembered diving into the interference of the opposing team to break up a play, but the subsequent events remained blank. How he got to his home he did not know. He had only the testimony of his friends that he had remained conscious except while he slept at night. Had he been asked he would have described the experience of diving into a massed interference as "the mere cessation of consciousness—nothing more." His memory was thus no adequate gauge of his state of consciousness in the intervening period.

Experiences of this kind do not, however, take away all the importance of the testimony that consciousness ceases. If the states of consciousness before and after death are disconnected, it does not mean personal immortality in any true sense. Further, though in some cases temporary loss of consciousness might occur, it would be surprising for the subject to become unconscious in every case if consciousness were to reappear at some later time after death. I know of no way in which the defendants of immortality can adequately answer this evidence.

Evidence of perhaps comparable weight but pointing in the other direction is given by statements such as the following, made by former President Little of the University of Michigan, himself a biologist of no mean standing:

> The death of my own parents within a day of one another completely wiped out pre-existing logical bases for immortality and replaced them with an utterly indescribable but completely convincing and satisfying realization that personal immortality exists. Such experiences are not transferable, but are probably the most comforting and sacred realizations that can come to any of us.

Far from being unique, such intuitive beliefs in immortality are sufficiently general to raise the question whether they may not be the true origin of the doctrine as it has been included in many religions. To such evidence likewise there is no adequate answer. Nevertheless, however convincing such intuitions may be to the person who has them, as Dr. Little intimates, they are of little value as evidence to anyone else, since they offer no objective data.

Can Consciousness Be of Value to a Dead Organism?

IN view of this failure to get conclusive evidence of a direct character, let us consider some of the more important deductions that have been drawn from the theory of evolution. An argument against immortality which carries considerable weight is based upon the value of consciousness to the organism. From the biological point of view the appearance of consciousness in animals enables them to compete more successfully in the struggle of life. This suggests that consciousness is the servant of the biological organism. In the evolutionary process we should on this view expect consciousness to appear only where it can be of some value to the organism with which it is associated. For a babe at birth consciousness is of little value, and it seems to be only feebly developed. In youth and maturity, however, it is of vital importance that the organism be aware of what is going on, and consciousness is accordingly most highly developed. Clearly, consciousness can be of no value to a dead organism. From the biological point of view, therefore, we should expect an efficient evolutionary process to bring about the cessation of consciousness with death.

There is, however, an alternative position which is at least equally tenable, and which points toward the opposite conclusion. This is that the evolutionary process is working toward the development of conscious persons rather than toward the development of a physical organism. In the previous chapters we have indicated how evidence from both the physical and biological sciences makes it difficult to escape the conclusion that our world is controlled by a supreme Intelligence, which directs evolution according to some great plan.

We could, in fact, see the whole great drama of evolution moving toward the making of persons with free intelligence capable of glimpsing God's purpose in nature and of sharing that purpose. In such a case we should not look upon consciousness as the mere servant of the biological organism, but as an end in itself. An intelligent mind would be its own reason for existence.

Our survey of the physical universe indicated that mankind is very possibly nature's best achievement in this direction. If in the world scheme conscious life is the thing of primary importance, what is happening on our earth is thus of great cosmic significance. The thoughts of man, which have come to control to so great an extent the development of life upon this planet, are conceivably to the Lord of Creation among the most important things in the world. From this point of view we might expect nature to preserve at all costs the living souls which it has evolved at such labor. This would mean the immortality of the individual consciousness.

Thus science finds itself incapable of

giving a definite answer, at present at least, to the problem of immortality. While according to the mechanistic view the mind could not survive the brain, the evidence seems definitely against this view, and no cogent reason remains for supposing that the soul dies with the body. The evidence of revived persons brought back from Hades, though inconclusive, must be considered strongly against persistence of consciousness. If consciousness is merely the servant of the living organism, we should expect the two to die together; but if, as seems perhaps more plausible, intelligent consciousness is the objective of the evolutionary process, we might expect it to be preserved.

Put Out the Light

THERE is a parable of a flame, which is said to have been told many centuries ago by Gautama Buddha to illustrate the futility of belief in a future life. He had been asked what becomes of the soul when a man dies. "Light a lamp for me," he countered. Then, blowing out the flame he asked, "What becomes of the light when the flame is extinguished?" What could be more dead than a flame that is out?

As seen by modern science the parable has a new significance, and has accordingly been elaborated by our distinguished American astronomer, Professor H. N. Russell. Let us take the flame to represent the body, and the light which comes from it the consciousness or soul. In a candle flame vapor comes from the wick and air comes from the side, forming a steady stream of burning gases passing continually through the flame. There is an intake of "food" and oxygen at one end, and an outpouring of waste products at the other. It is a kind of metabolism. The material of the flame is continually changing, just as the cells of our bodies change; yet the form of the flame remains the same. It is the same flame. But puff, and the flame is out! Is this the end? The flame is dead. What then?

What is happening to the light? The flame was material made up of atoms and molecules; but the light is a different kind of thing—electromagnetic radiation, flying away at tremendous speed. We know that if the candle was out under the open sky, its light was streaming into interstellar space, where it will keep on going forever. The flame was mortal but the light which it gave is immortal. More than that, the escaping light carried with it the story of the candle's life. If, on some far distant planet the light is caught in a spectroscope, it can tell that it was born of carbon burning in oxygen, and that the temperature of the flame where it lived was some fifteen hundred degrees. By a study of the light an amazing number of things could be found out about the flame from which it came.

Suppose, now, we can observe molecules but are blind to the light. Would we not have said with Gautama Buddha that the flame died, and that was the end? Is not this precisely our position regarding the life of man? His body we can observe, his mind we can only infer from the actions of his body. The body dies—is blown out. The light from the candle flame lived on through eternity, though the blind man could not see it. We know we are blind to the soul. How can we know that it does not go on living forever with a fulness of life corresponding to that of the light?

This parable has, however, an ambiguity similar to that which has appeared in our attempts at applying scientific reasoning. The comparison of the flame with the living body of a man is very satisfactory. Who can say, however, that the light from the flame should not be compared with the enduring influence of the man on his fellows rather than with his own consciousness. In this case the parable would imply nothing beyond the facts of common experience. What is thus brought clearly to our attention is, however, the fact that failure to find evidence for the permanence of consciousness is no adequate basis for rejecting its possibility.

God and Immortality

IF we desire to reach a more definite result, we must go beyond science into ethics and religion. Such an excursion is outside of the proper scope of this book, and its author can serve only as an amateur guide. Yet for sake of completeness the nature of these arguments should be indicated. It is recognized that they will not have the general appeal of well-tested scientific evidence; but for many of those who are prepared to accept the postulates on which they are based, these lines of thought carry such weight as to make a belief in immortality the basis for the planning of life.

One of the most effective of these arguments is that based on the belief that God is good. It is summarized by Barnes as follows:

We are forced to assume that the Universe is rational. The assumption is largely confirmed by our experience and, unless it were true, the Universe would be unknowable. In that case God's works and ways would be unintelligible and experience would not lead to any understanding of Him. Now if, on the contrary, the character of the ordering of all that happens is for our thought rational, we are forced to conclude that God would not have allowed the majority of human beings to have lives, so wretched and incomplete as we observe them to be, were it not that earthly existence is but the first part, a mere beginning of the complete life of the human spirit . . .

In brief, our plea for personal survival can be set out as follows. We have been led by the processes of reason to postulate that the world is the realm of Creative Spirit, of Mind which is purposive. Argument from the existence of the Moral Law or, in other words, of man's feeling that he is compelled to believe that goodness is objectively valid—such argument leads us to the conclusion that the Creative Spirit, in and for Whom the Universe exists, is good. But our arguments must be pronounced unsatisfactory, and the conclusions derived from them must be rejected, unless personal immortality be a fact.[3]

We have found strong reasons for believing that, in spite of his physical insignificance, man as an intelligent person is of extraordinary importance in the cosmic scheme. If we were to use our own best judgment, what would we say is the most important thing about a noble man? Would it be the strength of his body, or the brilliance of his intellect? Would we not place first the beauty of his character? A man's body is at its prime before middle life, and his intellect probably somewhat after middle life. But it takes a whole lifetime to build the character of a noble man. The exercise and discipline of youth, the struggles and failures and successes, the pains and pleasures of maturity, the lone-

[3] *Loc. cit.*, pp. 645–646.

liness and tranquillity of age—these make up the fire through which he must pass to bring out the pure gold of his soul. Having been thus perfected, what shall nature do with him? Annihilate him? What infinite waste!

> Thou wilt not leave us in the dust:
> Thou madest man, he knows not why,
> He thinks he was not made to die;
> And thou hast made him: thou art just.

Thus the poet cries, as he considers the impossibility that a God of justice and love should forget the men whom he has made to be his own companions.

Some writers have suggested that the Hebrews were the first to argue that since God has taken men into his fellowship, he would never permit death to separate them from himself.[4] Such passages as the following have been interpreted in this way:

> I will bless the Lord who has counseled me;
> In the night also my thoughts instruct me.
> I have kept the Lord continually before me.

4 Cf., e.g., A. E. Garvie, *Encyclopædia Britannica* (11th ed.), XIV, 338.

For, with Him at my right, I shall not be moved.
Therefore my heart is glad and my honor rejoices;
My flesh also dwells in security;
For Thou wilt not abandon me to Sheol;
Thou wilt not let Thy godly one see the pit.
Thou wilt show me the path of life.[5]

Nevertheless, even passages like this, whose interpretation is questionable, are rare in the Hebraic scriptures. More often we find comments on the finality of death:

Water departs from the lake,
And a stream parches and dries up;
So man lies down and does not rise.
Until the heavens are no more they will not awake,
Nor will they be roused from their sleep.[6]

Jesus, when pressed by the leaders of the Jewish Church to give his reasons for believing in a future life, replied,

But as touching the resurrection of the dead, have ye not read that which was spoken unto you by God, saying, "I am the God of Abraham, and

[5] Psalms xvi. 7–11 (Chicago, American Translation, 1927).
[6] Job xiv. 11–12 (American Translation).

the God of Isaac, and the God of Jacob"? God is not the God of the dead, but of the living.[7]

Primarily this was a reply in their own language to the conservative leaders of the Jewish Church, who were prepared to accept the literal phrasing of their sacred writings. But his emphasis on God as the God of the living is consistent with the spirit of his entire teaching, which emphasizes that God loves men as his children, and those that love him in return can be assured of his eternal companionship both in this life and the life to come.

Of the great religious leaders, Jesus seems to have been the first who saw immortality as a necessary consequence of his cardinal principle that God is a loving Father. So firmly was he convinced of the future life that he urged his hearers to live not for the present, but for eternity:

Blessed are ye, when men shall revile you, and persecute you, and shall say all manner of evil against you falsely, for my sake. Rejoice and be exceeding glad: for great is your reward in heaven.[8]

[7] Matthew xxii. 31–32. [8] Matthew v. 11–12.

That which made immortality a cardinal doctrine of Christianity, however, was his disciples' testimony of his own resurrection. In the teaching of the apostolic leaders, Peter and Paul, this testimony plays an essential part. Thus Peter, in his great appeal at Pentecost, states,

> *Him, . . . ye* by the hand of lawless men did crucify and slay: whom God raised up, having loosed the pangs of death: because it was not possible that He should be holden of it.[9]

Paul, writing to the Corinthians, makes this resurrection the very corner stone of the new faith:

> But if there is no resurrection of the dead, neither hath Christ been raised: and if Christ hath not been raised, then is our preaching vain, your faith also is vain.[10]

There can be no doubt but that the early Christians were convinced that Jesus had risen from the dead, and that this belief was an essential element in the vitality of the new religion.

As observed after nineteen centuries, in

[9] Acts ii. 23–24. [10] 1 Corinthians xv. 13–14.

an era of scientific thought, this evidence is, however, not such as can carry weight to one who approaches the religion from the outside. The witnesses are gone. What records they left have passed through the hands of many generations of Christians who were interested in justifying the claims of their religion. It is admittedly hardly possible to account for the growth of the new cult without assuming that its own leaders were convinced of its essential truth. Yet the bodily resurrection which may then have seemed easy of acceptance, now becomes an impassable barrier to one whose thinking is bound within the limits set by science. If this is not accepted, what weight can be given to the record of the witnesses?

For those within the inner circle, personal tests of the Christian doctrines have given confidence in their essential reliability. To some this may mean such a faith in the Bible's literal accuracy as a revelation that their thinking refuses to remain limited by scientific principles. Others, having felt the companionship of a God such as Jesus taught, will have gained a confidence in his religious intuitions, and will try to interpret these intuitions as best they may in light of his recorded sayings and of the data of science. To the former group, the present discussion will be of little value, since the principles of science will have been set aside when in apparent conflict with those of their religion. It is the latter group that may see in the principles of Jesus' teaching reason to believe in an immortality of consciousness which is not vetoed by the data of science.

It is safe to say that very few of those who accept the doctrine of immortality do so because of any logical argument. Scientists and philosophers alike have failed to provide any clear indication of what the future holds for us. The remarkable way in which Jesus' moral and religious teachings have satisfied the tests of centuries of experience, on the other hand, gives his followers a deep-rooted confidence in his religious intuitions. Jesus considers immortality the natural course of events in a world governed by God as a loving Father. "Lord, to whom shall we go? Thou hast the words of eternal life."

And so at last, it may be you and I
In some far azure Infinity
Shall find together some enchanted shore
Where Life and Death and Time shall be no more
Leaving Love only and Eternity.