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1929

THE ANNUAL GENERAL MEETING

OF THE

VICTORIA INSTITUTE

WAS HELD IN COMMITTEE ROOM B, THE CENTRAL HALL,
WESTMINSTER, S.W.1, ON MONDAY, APRIL 8TH, 1929,

AT 4 P.M.

DR. JAMES W. THIRTLE, M.R.A.S., IN THE CHAIR.

The CHAIRMAN called on the Hon. Secretary to read the invitation convoking the Meeting, which had been adjourned from March 18th.

The CHAIRMAN proposed that the Report being now in the hands of Members, be taken as read. He then proposed the re-election on the Council of Lieut.-Col. F. A. Molony, O.B.E., Lieut.-Col. Hope Biddulph, D.S.O., Avary H. Forbes, Esq., M.A., and Arthur Rendle Short, Esq., M.D., B.S., B.Sc., F.R.C.S.; also that Lieut.-Col. T. C. Skinner (late R.E.) be elected; and that Mr. E. Luff-Smith, the retiring Auditor, be re-elected, at a fee of three guineas.

Mr. HOSTE seconded this motion, which was passed unanimously.

Resolution No. 2 :—

“That the Report and Statement of Accounts for the year 1928, presented by the Council, be received and adopted, and that the thanks of the Meeting be given to the Council, Officers, and Auditor for their efficient conduct of the business of the Victoria Institute during the year.”

was moved by Mr. J. NORMAN HOLMES and seconded by the REV. HENRY M. WALTER, M.A., and passed unanimously.

Resolution No. 3 :—

“That the cordial thanks of this Meeting be passed to Dr. James W. Thirtle, M.R.A.S., for presiding on this occasion.”

was moved by Mr. WILLIAM C. EDWARDS and seconded by Mr. W. HOSTE, and passed by acclamation.

715TH ORDINARY GENERAL MEETING,

HELD IN COMMITTEE ROOM B, THE CENTRAL HALL,
WESTMINSTER, S.W.1, ON MONDAY, DECEMBER 3RD, 1928,
AT 4.30 P.M.

DR. JAMES W. THIRTLE, M.R.A.S., IN THE CHAIR.

The CHAIRMAN, at the commencement of the Meeting, announced with deepest regret the decease of Lieut.-Col. G. Mackinlay, long an active Member of the Council and a Vice-President, and he called upon those present to show their respect for his memory by rising in their seats.

The Minutes of the previous Meeting were read, confirmed, and signed, and the HON. SECRETARY announced the election of the following since the last Meeting:—Members: The Rev. Ambrose J. Wilson, D.D.; Ernest Hedgman, Esq.; the Rev. President J. E. Kuizenga, D.D.; and Dr. Alexander M. Elliot, O.B.E. Life Associates: Major A. H. Fraser and Dr. James Knight, J.P., F.R.S.E. Associates: H. M. Gilchrist, Esq.; Frederick H. Shand, Esq.; Horace J. Hannah, Esq.; the Rev. C. O'Neale Martindale, Ph.D., D.D.; Dr. E. F. Neve; A. T. Babbs, Esq.; G. Vanner Rowe, Esq.; and Dr. T. A. Neill Watson, M.C. Corresponding Member: The Rev. W. M. Douglas. Hon. Associate: The Ven. Archdeacon Jas. Adams.

The CHAIRMAN then called on the President, Dr. J. A. Fleming, F.R.S., to read his paper on "Matter, Energy, Radiation, Life, and Mind."

MATTER, ENERGY, RADIATION, LIFE, AND MIND.

By DR. J. A. FLEMING, M.A., F.R.S. (*President*).

THE present age is a period of keen scrutiny and analysis both of things and ideas.

We desire to discover if possible how far we have been able to penetrate behind the phenomena of Nature and arrive at any final truth as to structure and function.

Also we wish to know how far our conceptions and surmises as to the mechanism of the external world correspond to reality, if that be possible.

From time to time men of genius arise who are able to open a door and usher us into a new field of experience or mode of thought. We then begin a new chapter either in experimental science or in philosophy.

In a previous paper the writer has endeavoured to expound briefly the new ideas on the subject of Space and Time which have arisen of late years.*

To-day it may be interesting to give some account of our present position in regard to five other fundamental and general ideas, viz., those of Matter, Energy, Radiation, Life, and Mind, and their philosophic implications.

1.—MATTER.

Matter, which is a collective name for material substance, has been defined in many ways. J. S. Mill defined it as the permanent possibility of sensation. It has also been defined as that which occupies Space or as the vehicle of Energy. Its fundamental quality has been considered to be Impenetrability, which means that two samples of it cannot occupy the same space at the same time.

These definitions, however, do not carry us very far, and are, in fact, little more than equating one unknown quantity to another.

Experimental science has, however, made progress where Philosophical enquiry halts. We have been able to learn some very important things about material substance.

In the first place there are certain kinds of substance from which we cannot extract any different kind of substance. We shall see presently within what limits this statement holds good.

Thus from Water we can obtain two gases, viz., Hydrogen and Oxygen, but from these latter we can get no chemical substances different to themselves. These are called therefore elementary substances. There are about 88 kinds known, and there is some reason for thinking that not more than 92 varieties exist on our earth. All other substances are made up of mixtures or combinations of these elements, just as every word in the English language is made of a collection or group of some of the 26 letters of the alphabet.

The next striking fact is that Matter is molecular in structure. This means to say it is made up of little masses or molecules,

* *Relativity and Reality.* The Annual Address to the Victoria Institute given June 4th, 1928.

each one of which is similar to others in composition and structure.

The elementary substances are composed of atoms, and atoms grouped together form molecules. An atom may be defined as the smallest quantity of any element which has the chemical properties of that element.

Thus, for instance, if we could continue to divide up a bit of Copper into smaller and smaller particles, we should come at last to a piece which, if divided in two, the parts would no longer have the properties of the element Copper.

We also know something about the sizes and weights of these atoms. Broadly speaking, from 100 to 250 million atoms placed in a row in contact would make up the length of 1 inch.

The smallest length visible in a good microscope is about one hundred thousandth of an inch, so an atom is about $1/2500$ of the size of this smallest visible particle. There is little hope of our ever being able to see an atom. Nevertheless we know a good deal about them.

The word atom is formed from Greek roots meaning something which cannot be cut or divided, but the speculations of Democritus and the Greek philosophers had no certain basis of experimental fact.

No real knowledge was obtained until chemists began with the aid of the balance or scales to make quantitative analyses of compound substances.

It was then found that there is a definite and constant proportion by weight in which elementary substances combine to produce a compound.

Thus in the case of Water, which we can resolve into the two gaseous elements Hydrogen and Oxygen, the proportion by weight is 1 to 8. In the case of Marsh gas, which is a constituent of Coal gas and is a compound of Hydrogen and Carbon, the proportion by weight is 1 to 3. There is a common compound of Oxygen and Carbon called Carbonic acid, which is found to have a composition of 8 of Oxygen to 3 of Carbon.

These facts can be expressed in the form of two statements or laws as follows :—

When two elementary substances combine together chemically they do so as integer multiples of certain fixed weights. Thus in addition to Water, which is formed of Hydrogen and Oxygen in the weight ratio of 1 to 8, there is another compound called Hydroxyl formed of Hydrogen and Oxygen in

which the weight ratio is 1 to 16 or twice 8. In addition to Carbonic acid gas, in which the ratio of Carbon to Oxygen is 3 to 8, there is another compound called Carbonic oxide gas formed of Carbon and Oxygen at which the ratio is twice 3, or 6 to 8.

Again, there is a law of relative proportions which is stated as follows :—When two elements combine separately with a third element in certain ratios they combine also with one another in the same ratio or in some simple integer multiple of it. Thus Hydrogen combines with Oxygen in the ratio of 1 to 8 and with Carbon in the ratio of 1 to 3. Hence Oxygen and Carbon combine with each other in the ratio of 8 to 3 or 8 to twice 3.

When these facts came to be considered by the English chemist John Dalton of Manchester (1766–1844), they led to the conclusion that the best explanation is that elements such as Hydrogen, Oxygen, Carbon, etc., exist only in small indivisible masses called atoms which have different weights, and that compounds are only formed by integer numbers of atoms of different kinds and constant weight associating themselves into molecules.

The atoms themselves were imagined to be hard, unbreakable little particles of uniform size and weight or mass.

This atomic theory was not at first generally accepted, but as the years went on it was found more and more to be consistent with facts, nevertheless the atoms of the elements remained the ultimate constituents of Matter.

Then in 1897–8 a great step forward was made by Sir J. J. Thomson, the present Master of Trinity College, Cambridge, in his epoch-making discovery that we can extract from all atoms particles of a uniform kind, but vastly smaller and of less mass than the lightest of the chemical atoms. These are now called Electrons. Astonishing evidence was accumulated that these electrons taken together constitute the agency we call negative electricity.

Finally an hypothesis was put forward by Sir Ernest Rutherford that an atom is a solar system in miniature. It has a central orb called the nucleus which is composed of two kinds of particles, viz., protons, which are each 1,800 times the mass or weight of an electron but perhaps smaller in size. A certain number, one or more, of these protons held together by electrons form that nucleus. The nucleus of the Hydrogen atom is a

single proton and around it revolves a single electron like the moon round the earth. The nucleus of the Helium atom comprises 4 protons held together by 2 electrons, and round it revolve 2 planetary electrons like the two moons of Mars. So we go up step by step until we reach a final very complicated atom of Uranium, in which the nucleus consists of 238 protons held together by 146 electrons, and round this nucleus a family of 92 planetary electrons revolve.

These protons constitute the agency we call positive electricity. Between protons and protons there is a powerful repulsion and the same between electrons and electrons. But electrons and protons attract each other strongly.

The size of these particles of electricity is extremely small compared with that of chemical atoms. The electron is probably as much smaller than an atom as the smallest grain of dust is smaller than St. Paul's Cathedral in London.

All Matter is therefore composed of infinitely smaller particles of electricity, and if we could see an atom magnified to the size of, say, a large church it would seem to us to be no more than a few dozen grains of impalpable dust scattered and revolving in the above-named space.

These electrons and protons are held together by strong electric and magnetic forces, and the question then arises whether they are anything more than centres of force.

Quite recently a discovery of very great importance has been made by Professor G. P. Thomson, the son of the Master of Trinity, and this is that an electron in motion is accompanied by a system of electric waves which guide it and move with it. We shall explain presently what this phrase "electric wave" means.

The old view of the atom as a hard indivisible mass has thus been replaced by a theory which regards it as a cloud of electrons sparsely populating a space, and this again is giving place to a theory that the electron itself is a complicated structure of centres of electric force which when in motion are accompanied by or else create a system of electric waves. But the question is, waves in what medium and of what nature?

The electron theory is supported by the discovery of the radioactive substances, Radium, Thorium, and Uranium. These elements have large and complicated nuclei, and from time to time these break up and fling out electrons, called then Beta-particles, protons, and a special structure of 4 protons and

2 electrons which is called an Alpha-particle. In addition to these there are certain radiations called the Gamma rays of which more will be said presently.

What is left behind after this catastrophe is a new element. This again breaks up with elimination of Alpha- and Beta-particles and Gamma rays. Thus in the case of the element Radium itself, half of the atoms would break up in a period of 1,730 years, and the first formed residual element is called Radium Emanation, which in turn decreases to half in about 4 days. This again leaves a new element, and after manifold transformations the final result is to produce atoms of the metal Lead. Thus we have in a certain sense realized the dreams of the alchemists in transforming the elements. Not Lead into Gold, as they hoped, but spontaneously Uranium into Radium and Radium into Lead, though the complete change takes millions of years to effect.

The old-fashioned Materialism has therefore vanished before the slowly advancing front of scientific investigation. Matter is far more complex, fine-structured, elusive, and, we may perhaps say, spiritual than we formerly thought. Outside of ourselves there appears to be nothing but centres of electric force in rapid relative motion, and even these are seen, under the keen scrutiny of physical research, to be resolving themselves into systems of waves of some kind which appear for a little time and then vanish away only to make their appearance in another place.

Matter, however, only becomes known to us by the constantly reproducible perceptions of our own minds. The opinion therefore, that there is nothing in this Universe except Matter and its operations, has only been held by those who are ignorant of the necessary conclusions of critical philosophy.

2.—ENERGY.

Before we can consider in detail the nature of an electric wave we must devote a little space to the subject of Energy, which is the second fundamental entity in the physical Universe.

When any mass of matter is in motion relatively to others, whether it be celestial masses such as stars or planets or else bullets, molecules, atoms or electrons, it possesses the power of imparting motion to other masses of matter or of making some

changes in them which it would not do if at rest. Thus a bullet laid on a board makes no essential change in it, but a bullet moving very rapidly towards the board if fired from a gun will pierce a hole in it and tear wood out of it.

It is found that this property can be transferred from one mass of matter to another. Thus a croquet ball set rolling and colliding with another sets the latter in motion and perhaps comes to rest itself. Again the motion of large masses can be transferred to atoms and molecules, and thus give rise to heat which consists in atomic motion. We find that when measured in a certain way there is a certain quantity which remains constant in all these changes, and that the gain by one mass of matter is equal to loss by other masses. This quantity is called Energy, and it may be generally defined as that which is the cause of physical phenomena by its addition to or subtraction from matter or by its changes of form.

There is a close analogy between Matter and Energy in several respects. There are, as we have stated, various kinds of elementary Matter; and there are various forms which Energy may take such as Heat, Light, Energy of Motion, Energy of Strain or Displacement and Electric Energy.

Nevertheless, there is also a difference. We cannot convert, at present, the various kinds of elementary Matter freely into one another, but we can interconvert the various kinds of Energy.

There is, however, a law of Conservation which applies separately to both Matter and Energy. In all its changes of combination we ourselves cannot alter the total amount of each, or convert them into one another.

Energy must be therefore something which has the same claim to be considered real, as Matter. Nevertheless we have reasons for thinking that in the interior of Stars a transformation of Matter into Radiant Energy is taking place.

Just as Space and Time are merely different aspects of the same entity we call Space-Time, so Matter and Energy are merely different aspects of one reality. Matter is in short localized or concentrated Energy. This interconnection of Matter and Energy is shown by the impossibility of defining one except by relation to the other. Matter in Motion is said to possess Energy, and Energy is measured by the product of the Mass or quantity of Matter in a moving body and half the square of its velocity or speed.

It is necessary to be careful in our definitions of the various measurable quantities with which we are concerned. When a mass of matter is in motion such as a stone falling from a height, its speed and therefore its energy of motion is changing from instant to instant. The rate at which the kinetic energy is changing with time is called the Power absorbed or given out.

Power means therefore the time rate of change of Energy. The Energy of a body may change with the length of the path and the space rate of change of Energy is called the Force acting on the body.

Power and Force are therefore only names for rates of change, just as interest is the name for the rate at which money is lent, but it is not money itself.

There is another important quantity called Action. If we multiply together the number representing the energy of motion of a body and the time during which it possesses that energy we have a measure of the Action of the body.

In many cases the motion of a body such as that of a planet round the sun takes place under conditions such that the Action is less than would be the case if the body moved by any other path. This principle of Least Action combined with that of the Conservation of Energy enables us to solve many problems in Dynamics which is the Science dealing with Forces and Energy.

We also use the word Work in a technical sense to denote Energy expended. Thus, when a heavy body is lifted against the force of gravitation through a certain distance, its potential energy is said to be increased and we also say that Work has been done on it.

Energy or Work is always measured as the product of two factors one of which is of the nature of a distance and the other of a resisting force.

These terms Energy and Dynamics are derived from Greek words *Energieia* and *Dunamis*, and it is interesting to note that these are words which occur in the New Testament to describe operations or events coming about by exceptional exhibitions of Divine exertion or intervention. Thus, in the Epistle to the Ephesians, i, 19, Paul wrote, as translated in the Authorized Version: "And what is the exceeding greatness of His power to us-ward who believe, according to the working of His mighty power, which He wrought in Christ when He raised Him from

the dead." The words "according to the working" are in the Greek *kata tēn energeian*, and the words "greatness of His power" are *megethos tēs dunameōs autou*.

We see therefore that in considering the nature and operations of Energy we are coming very close to the spiritual sources of the material Universe. It is scientifically true that "the things which are seen are temporal, but the things which are not seen are eternal" (2 Cor. iv, 18).

3.—RADIATION.

We have in the next place to consider a special form of Energy called Radiation.

A few illustrations must first be given of the scientific meaning of the term *wave*. In ordinary custom we use the word to describe an up-and-down motion on the surface of water or the splashing up of the sea-water on the coast.

In a strict scientific sense it means any kind of change not limited to motion which is repeated periodically, that is over and over again, at any one place in some medium and is also repeated successively at equidistant places at the same time. The characteristic of a wave is that the same kind of changes are taking place simultaneously at equispaced distances called the wave-length, and that at any one place the same cycle of changes is being repeated in a time called the periodic time. The number of cycles of operation performed per second is called the frequency. Thus in the case of sound waves in air or water the change consists in a slight compression followed by a slight expansion of the fluid. The frequency of sound waves falls within the limits of about 100 and 10,000.

If we could watch a particular zone of compression we should see it shifting its place and moving over a distance equal to 1 wave-length in 1 period of time. This speed is called the phase velocity of the wave and in air at normal temperature it is about 1,100 feet per second.

The special peculiarity of a wave is that it is possible for two waves from one source to arrive at the same place, but so that the wave changes cancel or destroy each other. Thus two sound waves can travel by slightly different routes, but so that the condensation of one wave reaches the same place at the same

time as the rarefaction of the other wave and then they destroy each other's effect at that place. This is called *interference* and whenever we find it taking place we can be sure we are concerned with a wave of some kind.

This interference can take place with light. It is possible for a ray of light to be divided into two parts which travel to the same place by paths of slightly different lengths, and if that difference is equal to an odd number, *e.g.* 1, 3, 5, etc., of half wave-lengths the rays extinguish each other. We have then the curious effect that light added to light produces darkness. This could only happen if light consists in some kind of wave effect.

The questions then arise of what nature are these waves and in what medium do they exist ?

It has taken nearly a hundred years of investigation to find even partial answers to these questions.

The first has, however, received reply. The quantity which varies cyclically in a ray of light is the electric force at each point on its path. This force is at right angles to the direction of the ray and changes from a maximum in one direction to a maximum in the opposite direction, and this change is repeated periodically from point to point along the path.

In ordinary yellow light the wave-length is of the order of about one fifty thousandth part of an inch, and the frequency about 600 billion vibrations per second. The wave speed is about 300,000 kilometres per second or nearly 186,000 miles per second. The range of frequency which can affect the human eye as light lies between 400 billion which produces the red sensation and 800 billion which gives the violet. Beyond the violet there are vibrations of greater frequency which cannot affect the eye but impress a photographic plate. Beyond the red end of the spectrum there are also invisible rays called infra-red which have a heating effect. Beyond these again are the so-called Hertzian rays which pass by degrees into the long and longer wireless waves.

We are thus acquainted with about 60 octaves of radiation only one of which can affect our eyes as light. All this immense gamut of vibrations is essentially of the same nature, *viz.*, electric vibration, but they differ in wave-lengths which extend from many miles to an infinitesimal fraction of an inch.

In the next place it is necessary to discuss briefly the manner in which this electric radiation is created by the movements of

electrons and how these create variations in the electric force at various points in space.

If any of the physicists of a generation ago had been asked how light and radiant heat are produced, they would undoubtedly have stated that it was caused by the vibrations of atoms communicating their motion to a space-filling medium called the ether, just as tuning-forks set in vibration impart their motion to the air.

We now know, however, that if there is an ether at all it cannot be thus set in vibration by the movements of atoms, and that the properties of the ether are entirely different from those of any material substance, whether fluid or solid.

The theories of the ether which assumed it to have inertia and some kind of elastic resilience to distortion are now all abandoned and dead. All that we know as a matter of fact is, that if an electric force is made suddenly at any point in space, such electric force meaning some influence which would displace or move an electron if placed at that point, then the effect is not felt at all points in space instantly but spreads out from it with a velocity of 300,000 kilometres or 186,000 miles per second. Hence it follows that a periodic or cyclical electric force at any point, that is, one repeated over and over again, creates a wave of electric force, and this wave is a storehouse of Energy.

The sun, for instance, sends out from each square foot of its surface energy per second equal to 7,000 horse-power. The earth captures at best only 1 part in 47,000 of all this radiation, which means that in cloudless tropical regions about 7,000 horse-power is delivered to the earth per acre of surface. This energy takes $8\frac{1}{2}$ minutes to travel to us. During that time, after it has left the sun and before it reaches the earth, it must be stored up and conveyed by some medium in space capable of transmitting energy in the form of a vibratory electric force.

We do not yet know the true nature of this ether, or of this electric force, but the facts of wireless telegraphy and broadcasting bear witness to their existence.

We have already mentioned that in the atomic theory at present held, an atom comprises various planetary electrons revolving round a nucleus. When an electron is in an outer orbit it possesses more energy than when in an inner orbit. Hence to lift it from an inner to an outer orbit *work* must be done, and when it falls back again energy is liberated. This liberated energy takes

the form of a stream of electric waves which pass away into space.

As long as we think of the electron as a tiny ball revolving round its nucleus like the moon round the earth, it is very difficult to see why this sudden change of orbit is accompanied by the production of emitted electric waves. If, however, the electron itself is only a system of electric waves, and if the energy of this wave-system is greater the larger the electron orbit, then it is not difficult to see that the difference of these wave energies may be flung out as another wave travelling away from the atom in the form of radiation. Experiment has shown that the frequency of the radiated waves, that is the number per second in the train, is given by the difference of the energies of the electron in its two positions divided by a certain constant, called from its discoverer Planck's Constant.

To take the simplest case, viz., an atom of hydrogen with one planetary electron. If this electron jumps or is knocked from an outer to an inner orbit, the emitted radiation has a definite frequency and wave-length and produces a single bright line in the visible spectrum.

The important suggestion was made some years ago by Dr. Niels Bohr, a Danish physicist, that for each atom there are only a certain number of permissible orbits in which the planetary electrons can revolve. It is just as if round a city there were only a certain number of circular roads along which motor cars could run, but not in intermediate routes.

We do not yet know the reason for this, but its probability is confirmed by deductions from the hypothesis.

Hence there are many different jumps which an electron can take from one orbit to another, and hence many bright lines due to corresponding radiations in its spectrum.

Atoms are therefore very complicated structures, in fact, as one eminent physicist has said, a grand piano is a very simple kind of structure in comparison with an atom of iron. At every stage in our investigation of its architecture we are as clearly met with evidence of purpose and design as we are in the case of the most complicated chronometer or wireless receiver.

We cannot invoke, as an explanation of their origin, any process, such as a struggle for existence or survival of the fittest, as there are no intermediate types. The 88 kinds of atoms we know are distinct or separate, those of each particular form are absolutely

similar in structure and performance. They are like coins struck in a Mint and they each bear the impress of the image of their Maker in the attributes they possess.

Nevertheless, they have, like all created things, a certain life or duration. The radio-active atoms are constantly changing, and Matter is in a state of flux. That which we can see happening very quickly in certain derivatives of Radium or Thorium may be taking place in atoms of all kinds, but much more slowly.

It has also become increasingly clear that Matter, that is atoms, can be converted into Radiation, and there is a certain definite rate of exchange. Thus the long-standing puzzle of the source of the heat and light of the sun and stars has been solved. Their radiation results from a loss of mass.

Our sun wastes away at the rate of 250 million tons a minute to supply the heat and light it sends out. No one, however, need be afraid it will not last out our time since the mass of the whole sun is somewhere about 2,000 billion billion tons.

Nevertheless, neither sun nor stars are everlasting, but are slowly vanishing away, by conversion of Matter into Radiation, unless in some places there is a compensating reconversion of Radiation into Matter.

It would not be inappropriate to speak of Radiation as disembodied Energy in motion. If we discard the hypothesis of an Ether, for the existence of which there is no direct experimental evidence, all that we actually know is that Energy can be transmitted through space in a form or by a process called Radiation. All along the line of propagation, but at right angles to it, there exists a state in the space called electric force or displacement. At any one place this effect varies cyclically, that is, from a maximum in one direction to a maximum in the opposite direction, with gradually varying values. At any one instant all along the line of propagation there is the same kind of cyclical variation.

This variation in time and space is called an electric wave. The Energy travels forward with the displacement at a speed of 1,000 million feet per second in empty space. If an electric wave is started at one spot its effect is not felt for one-millionth of a second at a place 1,000 feet away. A wireless wave (which is an electric wave) travels right round the earth in about a seventh of a second.

Matter in the form of chemical atoms consist of localized Energy. Matter and Radiation are therefore interconvertible

because they are essentially of the same nature. Without Energy there would be no events or phenomena in the external world, but we cannot describe it in any simpler terms.

The nearest approach we can make to an interpretation of it is that it is the result of the ever-acting Will of a Divine Mind present at all times and in all places. What we call the laws of Nature are, as H. C. Oersted says, "only the Thoughts of God."

4.—LIFE.

We turn next to the consideration of a subject in which the problems to be resolved seem even more difficult than those which present themselves when we are dealing with inanimate material substances. We are surrounded not merely by inert matter, or even matter possessed of energy of some kind, but by an immense variety of structures we call living, broadly divided into animals and plants, although in their very lowest forms this differentiation becomes difficult.

The characteristic of these living substances is that they exist in certain well-marked forms called species, and the individuals which form a species resemble each other far more closely than they do those of a different species. Each individual increases or grows, and to do this absorbs or takes in nourishment which may be non-living matter. Each individual in general has a certain duration or life, and by various means reproduces other individuals of a similar type or propagates itself.

The most important fact about all living structures, whether animals or plants, is that they are built up of an agglomeration of very small elements called "cells." The cell is the atom or unit of organic life just as the molecule or chemical atom is the unit of inorganic or non-living substance.

The cell itself consists partly of non-living material and partly of materials called protoplasm, composed of organic colloids of complicated chemical constitution. The word "colloid" may need a brief explanation. An eminent chemist (Thomas Graham) found that there is a remarkable difference between such materials as water containing common salt and a dilute glue or gum produced by putting solid glue or gum into warm water. One difference is that the salt solution will pass through blotting paper or a filter, but the gum will not. We can filter the dirt out of

dirty sea water and obtain a clear solution but we could not filter dirty gum in a gum bottle. The gum will not pass through the filter. Graham called substances like gum water Colloids, from the Greek word *Kollē*, meaning glue. He called substances like common salt Crystalloids. There is, however, no sharply marked division of substances. Some materials can exist in both states either as crystalloids or colloids. The latter have in general very complex or bulky molecules formed by the union of a large number of atoms. The colloids which occur in animal or vegetable cells are composed of atoms of carbon, hydrogen, oxygen, nitrogen and, perhaps, sulphur or phosphorus, built up into compounds called proteins, fats, albumens, carbohydrates, etc.

The study of cell structure and function, which is now called Cytology, has shown us a wonderful series of operations connected with the production of a cell. The simplest forms of living organisms consist of a single cell, but the higher animals and plants are composed of billions of cells which form an organic community, particular functions or duties being allocated to certain groups of cells, and all acting together in health not for themselves but for the good of the community as a whole.

When a single living cell such as that forming an amœba found in sea or pond water is examined, we find it to consist of a little blob of a jelly-like substance four-fifths of which is water, the rest being colloids and certain crystalloids. At rest it has a nearly globular shape, but it never is for long at rest, but is slowly changing its shape and moving about in the water holding it in search of nourishment which it takes in, and it also gives out particles of debris or undigested material.

The most recent investigations, such as those of Professor A. V. Hill described at the 1928 British Association Meeting by Professor F. G. Donnan, have shown that in each cell the continuance of the life processes is dependent on the operation of Oxygen, possibly required to oxidize certain cell materials and remove them from it. Living protoplasm continually produces materials which put a stop to its life unless they are taken from it. This, however valuable as a fact, gives us no explanation of the essential nature of living substance and why it has its remarkable powers of motion, assimilation and development.

When we examine a living cell from an animal body under a microscope we find in the jelly-like mass certain things. In the first place, there is often a more transparent globule called a *vacuole* which seems to be concerned with fluid motions in the

cell. Then there is a more important object called the *nucleus*, which is essentially connected with the life of the cell. If the cell is cut into two unequal parts that which contains the nucleus goes on living; that which does not contain the nucleus dies.

This nucleus at an early stage exhibits a sponge-like or net-like structure. Then after a time this changes to a sort of tangled thread. Later on this thread divides itself into short lengths called *chromosomes*, which are always the same number in all the cells of an animal or vegetable of the same species, and always an even number.

The next stage is when all these chromosomes divide lengthways so as to double their number. When this is done half of them move to one side of the cell and half to the other. The jelly-like mass then constricts itself to an hour-glass shape and nips into two parts. Each part then grows up to a complete cell with its nucleus and chromosomes. This fission is the process by which cells are made and multiplied. No one has ever succeeded in making, by artificial means, a single living cell of any type. It can be and has only been produced from a previously existing living cell. Hence spontaneous generation is a myth.

We have then to try to explain the origin of and peculiar powers of the organic cell. Several theories or hypotheses have been advanced.

One view, called the vitalist theory, assumes that there must be some fundamental difference between living matter and non-living colloids, and that the operations of living cells are not merely due to chemical and physical forces or agencies as known in connection with non-living matter.

This view has been combated by those who hold what is called the mechanist theory, in which it is assumed that the process of cell-production is the result of structure and of the operations of simply physical agencies or forces.

The late Professor T. H. Huxley at one time said that there was no more need to assume any recondite agency called "vitality" in connection with living cells than to assume something called "horology" to explain the action of a clock. The clock is a piece of mechanism to which energy is supplied on winding it up, and its subsequent operations are merely the result of its mechanical structure utilizing this energy. The mechanistic theory assumes the same thing to be true of a living cell.

There is, however, a strong argument against this mechanistic theory of the organic cell as follows :—

The multiplication of cells by fission does not result merely in the production of a disorderly mass of cells, but in the upbuilding of an animal or plant in which all parts of the structure are related to each other and subject to a general idea or purpose. When a hen's egg is gently warmed in an incubator for a few weeks this cell multiplication takes place inside the shell. But after certain days the shell cracks and out steps a living chicken with powers of motion, nutrition, and sensory organs completely formed.

The mechanist theory has certainly not given a complete explanation of this daily wonder ; hence a large number of biologists have abandoned it. Even the elementary process of cell division cannot be explained by it. An eminent Bio-Chemist, Professor Benjamin Moore, says in his book, *The Origin and Nature of Life*, p. 222, concerning this cell-fission : " There is nowhere outside living matter a set of energy phenomena found to occur *spontaneously* at all resembling this remarkable sequence of changes. . . . There is a type of energy at work never found elsewhere than in living structures." He has therefore suggested the term *biotic* energy for this type of energy upbuilding the cell structure.

It seems to me, however, that this is not a sufficient explanation, for the reason that what is required is not merely an energy but a *directing power* of some kind which can manipulate and guide the materials, the organic colloids, etc., into particular forms.

All physical quantities or agencies are divided into two great classes called scalars and vectors. The scalars are measured by one single number and are undirected quantities such as mass, temperature, and energy ; on the other hand the vectors are directed quantities. We have to measure them by two terms, and not only say how much or in what degree they exist, but in what direction they operate. Such quantities as forces, velocities, and momenta are vector quantities.

In connection with the living, multiplying, and upbuilding cell of organic life there is unquestionably some intelligence and foresight or purpose present. Accordingly another school of naturalists have been compelled to assume that living matter has psychic powers in addition to chemical and physical properties.

In a short controversy on the subject of Evolution which

took place in the *Nineteenth Century and After* review in November, 1927, January, February, March, and April, 1928, between the present writer, Mr. G. H. Bonner, and Sir Arthur Keith, the last-named eminent anthropologist maintains the above view in the words: "It is the inherent and essential quality of living matter that it can both plan and execute; unless Matter is purposive it cannot be alive. For modern students the 'thinker' and the 'thought,' the directing intelligence, do not lie outside living matter as Mr. Bonner and Dr. Fleming seem to think, but are of the essence of its constitution."

Nothing could possibly be clearer than the meaning of these words. Every particle of living matter in a cell must then know what to do in the production of a cell, and all the cells produced must know what is their ultimate objective and how to co-ordinate with the others so as to build up the body of a certain animal or plant of particular type in which they have never taken part before.

It is difficult to mention any well ascertained facts which justify this theory of psychic properties possessed by living matter, whilst very much can be said against it.

The question will be again considered in the next section on "Mind." Meanwhile it seems doubtful whether the term "living matter" can be applied to any particular and special substance. The animal or vegetable cell has a very complex constitution in mere material.

It is very well known that the green material called chlorophyll in the outer tissues of plants has the power of utilizing energy from sunlight, and building up out of water and the gas carbonic dioxide in the air and ammonia substances which ultimately form the organic colloids of cells. From these are formed more complicated chemical plant-products. These again are then used by animals as food, and provide the energy and materials required to build up the cells and structures of the animal body.

It may be a question whether any of these complicated substances entering into cell structure possess *per se* any peculiar quality or endowment apart from their special chemical and physical state which would justify the use of such terms as vitality or vital condition in connection with them, but they are the materials with which some Directing Power works to build up organisms we call living. There is no escape from the

conclusion that psychic qualities are evident in living matter but it is not evident that these are simply intrinsic qualities of the matter itself. They are evidence of Mind, but that Mind is an over-acting directivity, a control which is not self-produced nor self-maintained by the material, but is distinct from the material controlled.

The tendency of much scientific thought on biological subjects seems to be in the direction of searching for some broad general principles which will dispense with the necessity for the assumption of any such guidance by a self-conscious Intelligence, and render the world of animal and vegetable life the mere outcome of the operation of automatic forces or of the conditions imposed by exuberance of multiplication. Such conceptions as the struggle for existence, the Survival of the Fittest, Natural or Sexual Selection, reduce the production of the world of living things very much to chance. The multitude of beautiful forms and adaptations we see in animal and vegetable life cannot be the result of a blind struggle of mere amorphous living matter to continue to exist. The choice in the last issue is between Design and Chance. Design implies Thought, and Thought is the action of Mind.

It is not to be denied that there are in the Inorganic world certain general physical principles such as those of Least Action or the Conservation of Energy, and there may be others of similar kind at work in the organic world. We contend, however, that whilst these may be the tools or implements with which the Creator has worked, they do not obviate the necessity for guidance in their use. Creation, in short, is an ever-continuing process.

Our large telescopes show us, on the confines of the stellar Universe, stars and star-systems in process of making, though in our observations of to-day, on account of the abysmal depths of space, we are watching events which took place millions of years ago.

Nevertheless they give support to and endorse the words which Immanuel Kant uses in one of his writings, where he says:—*“Die Schöpfung is niemals vollendet. Sie hat zwar einmal angefangen, aber sie wird niemals aufhören,”* which may be rendered: “Creation is never completed. It had indeed a beginning but it will never have an end.”

On this subject of life some impressive words were uttered in a British Association Presidential Address at Exeter in 1869, by a

former very illustrious President of this Victoria Institute, viz., Sir George Gabriel Stokes, sometime President of the Royal Society of London. He said, "What this *something* which we call life may be is a profound mystery. It would be presumptuous indeed to assume we have already reached the last link, . . . a stage where further progress is impossible, and we can only refer the highest law at which we are stopped to the fiat of an Almighty Power. Let us fearlessly trace the dependence of link on link as far as it may be given to us to trace it, but let us take heed that in thus studying second causes we forget not the First Cause, nor shut our eyes to the wonderful proofs of design, which in the study of organized beings especially meet us at every turn."

5.—MIND.

The fundamental difficulty of all philosophy is the essential duality created by Subject and Object; Observer and Thing or effect observed; that which is Self and that which is Not-Self; or between Matter which is a permanent possibility of sensation and Mind which is the seat of sensations and perceptions. One of these cannot be defined without naming the other. The old epigram embodies this idea. What is Mind?—No matter! What is Matter?—Never mind!

A certain school of scientific thinkers have endeavoured to annihilate this duality by the postulate that Matter is a double-faced entity, to use the words of Alexander Bain, which has both physical and psychical properties or sides.

This single substance, says Bain, "has two sets of properties or two sides, the physical and the mental, but is nevertheless one substance, and the only substance which exists in the Universe."

This Monism as a philosophy has been revived again since Bain propounded it. It was crudely expressed by Haeckel and supported by Tyndall. We have seen that Sir Arthur Keith assumes living matter can "plan and execute" and is "purposeful" in power. These latter terms are, however, qualities not of Matter but of Mind.

We all recognize that whilst mental qualities, perceptions, emotions, and sensations can be more or less, large or small, they cannot be measured in terms of the units we employ in the quantitative measurement of Matter. There is no sense in

speaking of 10 pounds of love, or 4 square feet of joy, or a cubic foot of intellect.

Then, again, if this double-faced unity, commonly called Matter, has both physical and psychical properties united in it, how comes it to pass that these two different sets of properties can be so easily separated?

Let us consider a small portion of brain tissue. This considered as Matter has mass, volume, area, density, and a number of other physical qualities. According to Sir Arthur Keith this living substance can both "plan and execute," and has psychical properties. Suppose we give it a small electric shock, not sufficient to alter its physical properties, but just sufficient to "kill" it or render it lifeless or dead. We have not altered its main physical properties, but the psychical powers have vanished.

If matter is a double-faced entity with two sides to it, how is it we can separate these sides? We cannot separate the two sides of a coin, nor the inside from the outside of a vessel or box.

Again, how comes it to pass that there is no proportion or connection between the degree of the physical and of the psychical qualities if they are merely the two sides of the same entity?

It is true that the different parts of the brain are concerned with various sense perceptions, bodily motions, and mental faculties, but the immense difference between the small mental powers of the very ordinary man and those of some exalted genius, a Faraday, a Handel, or an Einstein, do not seem to be correlated to any proportionate bulk of brain, or even as far as can be seen to brain structure.

The materialistic biology which finds mind only in brain operations, and declares that what we call Mind or Soul vanishes with the destruction or death of the brain, finds its great support in the fact that we have little direct evidence of intelligence divorced from brain, if we except the rather uncertain testimony of psychical research or Spiritualism, when all allowances are made for conscious or unconscious deception, or for the subconscious powers of the human mind.

There are, it is true, an ever-accumulating number of physiological facts which show the very close connection between body and mind in human beings. Of late years the researches on what are called the ductless glands in our bodies which produce

substances called *hormones* have revealed very extraordinary facts.

There are glands called the thyroids in the neck. If these are deficient at birth, growth of the child in body and mind is hindered, and a peculiar kind of dwarf with stunted intelligence called a *cretin* results. The disease can often be remedied by giving food containing the thyroid gland of animals, and within a few weeks great improvements produced not only in body but in mind.

The decay of intelligence in some old people is possibly connected with deficient function of the thyroids.

But all these things do not prove that Mind is nothing but the functioning of the body. They merely exhibit proofs that the relation of body and mind is closely similar to that between the musician and his musical instrument. We cannot discover the musician merely by taking a piano to pieces. If the latter is defective or is injured, the musician, however skilled, can produce only imperfect music. But the instrument alone, however perfect, can produce no music at all.

There is another fact which seems to support the view that there is something else in a human being than a body, and that is the continuous sense of personal identity we each possess. In spite of all bodily changes due to age or disease or normal tissue changes, and in spite of all lapses of memory, there is not merely a self-consciousness, which is the result of the Mind becoming an object to itself, but there is a sense of the continuous inter-connection of this self-consciousness from day to day.

There is something in us which endures, no matter what else changes. It is this which really constitutes the basis of moral responsibility and the true self. It will be remembered that Bishop Butler, the author of *The Analogy of Religion*, has a brief but important Dissertation on "Personal Identity" in his book.

Amidst all the flux of material atoms in the body and tricks of memory in the mind, there is some element in us as human beings which preserves and constitutes personal identity. It is this element which we believe survives the death of the body and is the controlling power in it whilst it is alive.*

* There are curious abnormal cases known to psychologists in which one and the same person as regards body and brain may yet exhibit totally different characters, dispositions, and recollections at various

We have had a very confident assertion to the contrary made this year (May, 1928) in a Ludwig Mond lecture at Manchester, on the "Implications of Darwinism," by Sir Arthur Keith. He assured his audience that "every fact known to them (*i.e.* biologists) compels the inference that mind, spirit, soul are the manifestations of a living brain just as flame is the manifest spirit of a burning candle. At the moment of extinction both flame and spirit cease to have a separate existence." In other words nothing at all survives the death of the human brain.

It would be almost waste of space to put down the names of even a score of those, the most illustrious and greatest of our race, who have given even life itself in support of the contrary opinion. Their names are indelibly inscribed not merely in cathedrals or on tombs, but on the pages of history and in those inspired Scriptures which countless multitudes accept as the Word of God.

Ascertainable truth is not limited to that which can be experimentally demonstrated in a biological laboratory, nor to that which can be resistlessly proved to the reason by rigid logic alone. We have a right to consider that the heart and the conscience are as closely in touch with realities as is the intellect. Tennyson gave expression to this idea in words of perfect form in his "In Memoriam" :—

"If e'er when faith had fall'n asleep,
I heard a voice 'believe no more,'
And heard an ever-breaking shore
That tumbled in the Godless deep ;

"A warmth within the breast would melt
The freezing reason's colder part,
And like a man in wrath the heart
Stood up and answer'd 'I have felt.'"

times, the transition from one state to another being quite sudden. Whatever the true explanation of this phenomenon may be, it is at least consistent with the belief that the brain is not the only element involved in personality. On the other hand some injury to the brain may deprive a person of a knowledge of his own name, or who he is, or where he lives. This, however, is only an illustration of the fact that the Mind cannot express itself in our present state of existence except through the brain. The musician cannot express himself musically except through his musical instrument, but for all that, the musician is not identical with his instrument but has a separate existence, and may survive even when his instrument is destroyed.

But however deep or widespread our human intuition, or passionate our hopes, a courageous philosophy will always recognize that because we wish for or anticipate a certain condition it does not in the least follow we shall reach it.

If we are to retain our belief in the special psychic nature of humanity, in its essential differentiation from the animal creation and in a life beyond the grave, we need a more solid foundation than hopes or emotions if that faith is to withstand the subtle but determined attacks made on it to-day in the name of science or literary criticism.

We have that foundation in the evidence, external and internal, of the historical veracity of the events and statements made to us in the writings of the New Testament and in the record of their effect on humanity during nineteen hundred years.

These narratives and records have survived the most ingenious attempts to reduce them to a slender basis of normal events embroidered by myth. In a past generation Strauss, Renan, and others did their best to this end, but their work has withered and the facts remain.

Before the modern biologist can announce so confidently that bodily death ends personal existence for human beings, he has first to explain, if he can, the Resurrection and Post-Resurrection Appearances of Jesus Christ, because it is on those historical facts that the Christian faith is established and belief in a future life for those to whom He communicates life.

There are many who consider that the natural and intrinsic immortality of the human soul is not a truth taught in Scripture, but there are deep mysteries involved and a dogmatic tone is not admissible.

Let me conclude, however, with an additional quotation from the British Association Presidential Address in 1869 of our former Victoria Institute President, Sir George Gabriel Stokes, who, as Lucasian Professor of Mathematics at Cambridge and occupant of the Chair held once by Sir Isaac Newton, claims always our closest attention. Speaking of the human Mind, he says :—

“ When from the phenomena of Life we pass on to those of Mind we enter a region still more profoundly mysterious. We can readily imagine that we may here be dealing with phenomena altogether transcending those of mere life in some such way as those of life transcend, as I have endeavoured to infer, those of

chemistry and molecular attractions, or as the laws of chemical affinity in their turn transcend those of mere mechanics.

“Science can be expected to do but little to aid us here since the instrument of research is itself the object of investigation. It can but enlighten us as to the depth of our ignorance and lead us to look to a Higher Aid for that which most nearly concerns our well-being.”

DISCUSSION.

Dr. THIRTLE (Chairman), said : I feel sure that I voice the desire of all present when I move, as I do with profound pleasure, that a vote of thanks be returned to Dr. Fleming for the paper read in our hearing. Once again the honoured President of the Institute has placed thoughtful students under a sense of deep obligation, by indicating with strength and clearness what may rightly be pronounced the basic grounds of Christian confidence ; he has, in fact, directed our thoughts along lines that make for mental stability, and, as a consequence, we are enabled the more definitely to distinguish between phenomena and reality, between things observed and the forces or principles that lie behind all that we can see or feel in wide spheres of knowledge or experience.

It has been our privilege to follow the President in a series of discussions that yield conclusions of great practical importance. To begin with, dealing with Matter, he showed that the old-fashioned Materialism has retired before the advancing front of investigation ; and the perverse opinion that there is nothing in the Universe except Matter and its operations can only be held to-day by those who are ignorant of the necessary conclusions of critical philosophy.

While sincerely thankful that this truth has been placed before us in a convincing light, we welcome with equal satisfaction the President's discussion of the related subject of Energy—by which we are brought into more intimate contact with the spiritual and unseen sources of the Universe of things that are seen and material.

By his treatment of Radiation, Dr. Fleming has conducted us to thoughts regarding a deeper reach of ideas—to the consideration of a special form of Energy, involving electric vibration, atomic

structure, and much beside. We have listened with rapt attention to considerations advanced as only a master in science could formulate them. We found ourselves in presence of mystery and marvel, and in the result we realized a greater sense of the ever-acting will of a Divine Mind, present at all times and in all places, enabling us to agree in the definition of Oersted, who declared that the Laws of Nature are in reality the Thoughts of God (p. 24).

Proceeding to discuss Life, the President expounded cell-structure and function, and along various lines of argument he more than encouraged us to treat with impatience the evolutionary theories which are so widely current at the present time, and to see in the psychic qualities of living matter evidence of Mind, and that Mind "an over-acting directivity, a control which is not self-produced nor self-maintained by the material, but is distinct from the material controlled"—I quote the words of the President, words of decisive significance, as we shall assuredly admit (p. 29).

Finally, we have been privileged to listen to a discussion of Mind. Here we were shown the distinction between physical and psychical properties united in Matter, with a study of brain substance and function. We are truly thankful to Dr. Fleming for meeting, in terms consistent with philosophical theory and at the same time fully informed with regard to Divine Revelation, the vaunted demand of some that "death ends all." He has not only shown this contention to be unscientific, but declared it to be contrary to the warrant of faith as we know it to be established on grounds that evade the touch of scientific investigation. As he tells us: "Ascertainable truth is not limited to that which can be experimentally demonstrated in a biological laboratory, nor to that which can be resistlessly proved to the reason by rigid logic alone. We have a right to consider that the heart and the conscience are as closely in touch with realities as is the intellect" (p. 33).

In this region of thought we are enabled to yield authority to Divine Revelation, made sure by "many infallible proofs." Here we have our stand-by in the doctrine of "Jesus and the Resurrection." A risen Christ, who brought life and immortality to light by the Gospel, authenticates the faith and hope which sustained saints and martyrs, past and present, and, moreover, is the confidence of millions of all races in many lands to-day. The researches of science have their sphere, and the theories of philosophy may well

demand a place ; but over and above these there is the region of faith, wherein nourishment of the spirit is found by men and women who by experience have come to realize a knowledge of God, as revealed in our Lord and Saviour Jesus Christ.

With these remarks, it gives me pleasure to move a vote of thanks to the President for a paper which has been full of light and uplift to all who have listened this afternoon.

Mr. SIDNEY COLLETT said : Our first thought this afternoon must be of wonder and amazement at the marvellous way in which our President has dealt with these profound subjects. Parts of his paper are necessarily above and beyond some of us ; but we thank him most heartily, not only for his wonderful grasp of those mysteries of Nature's Laws, but also for the felicity and simplicity of the language he has used. His arguments are so cogent and unanswerable, and his illustrations so apt and intelligible, that his paper has helped us more readily than we otherwise could do to realize some of the wonderful works of God.

The reverent and fearless way in which he has denounced such foolish errors as that of the spontaneous generation of Life, together with his whole line of argument, all go to prove that *true* science does not contradict, but confirms, the statements of God's Holy Word. And, further, his remarks support the remarkable statement made by Sir George Darwin when President of the British Association in 1905, viz., "The mystery of Life remains as impenetrable as ever !"

I gladly, therefore, second the vote of thanks moved by our Chairman, for I am sure we must all feel that Dr. Fleming deserves our most grateful thanks.

Mr. AVARY H. FORBES said : "Spontaneous generation is a myth" (p. 26). Many years ago I heard Tyndall, at the Royal Institution, explain his experiments which led directly to this conclusion. A couple of years ago a Professor of Bacteriology (delivering the "Tyndall Lectures" at the same institution) said that the French physicists were at issue with the British on this point, and maintained that their experiments pointed to spontaneous generation being a fact. Can Dr. Fleming say if this contrariety of opinion still exists ?

Mr. PERCY O. RUOFF said: The Victoria Institute owes Dr. Fleming a great debt for his informative and lucid paper. The section dealing with the persistence of personality after death is very important. Marcus Aurelius has laid it down with considerable dogmatism that Alexander of Macedon and his groom are equals now in death, for both have either been received back into the same generative principle of the Universe or dispersed impartially into the atoms. This is a hopeless philosophy and stands in sharp contrast to the Bible revelation, which shows that personality persists after death. Christian personality is sacred, because it arises from the working of God within the human spirit, and it endures for the same reason.

The paper covers a very wide range of scientific facts, taken from many fields. Many of these facts set forth the exceeding glory and power of the Lord Jesus Christ, for it is revealed in Holy Scripture that He is not only the Creator, but "He upholdeth all things by the word of His power" (Heb. i, 3), and it is this knowledge that invests His Presence with His people in this world with such intense and supreme importance.

Rev. C. E. STOCKS said: Some of you may remember how Robert Blatchford, founder and editor of *The Clarion* newspaper, and a prominent opponent of Christianity, was compelled to acknowledge, a few years ago, that the discoveries of modern science had knocked the bottom out of his materialism. There was no longer any "matter" on which he could take a firm stand. He must now turn his attention to the unseen and the spiritual. We can be profoundly thankful that God is thus, through His book of Nature, confirming the truth of the book of His Holy Word.

Rev. J. J. B. COLES wrote: One of the chief merits of this most valuable paper is the very clear way in which the teaching of Monism is set forth. Sir Arthur Keith (*see* p. 28) asserts: "It is the inherent and essential quality of living matter that it can both plan and execute; unless Matter is purposive it cannot be alive. For modern students the 'thinker' and the 'thought' . . . do not lie outside living matter as Mr. Bonner and Dr. Fleming seem to think, but are of the essence of its constitution." And in his *Implications of Darwinism*, he assured his audience that "every

fact known to them (*i.e.* the biologists) compels the inference that Mind, Spirit, and Soul are the manifestations of a living brain, just as a flame is the manifest spirit of a burning candle. At the moment of extinction both flame and spirit cease to have a separate existence." In other words, nothing at all survives the death of a human brain. Later on, the science of Psychology which is still in its earlier stages, will teach us more than we can learn from Sir Arthur Keith. When we come to study the psychology of the Pauline Epistles, and such passages as "when it pleased God to reveal His Son in me," and "when Christ, who is our life, shall appear, then shall we also appear with Him in glory," then we shall understand better the meaning of Eternal life. Science may set before us the evolutionary processes of the divine Creator, but on *its own confession* it knows nothing of origins and nothing of resurrection or the life to come.

AUTHOR'S REPLY.

Dr. J. A. FLEMING: I do not think it will be necessary for me to say more in conclusion than to thank very sincerely the various speakers, and especially our esteemed Chairman, for their kind reception of the paper I have submitted. It is, I think, of great importance to set forth as clearly as possible the arguments against the subtle and insidious anti-religious tendencies of to-day, and especially against those which deny any future life or responsibility. Although the old-fashioned materialism has been invalidated by scientific advances, there is a modernized form of it which gives denial to the spiritual nature of man, ignores the inspiration of Holy Scripture and the great truths of redemption there revealed, but endeavours by psychical research, to penetrate, without the guidance of revelation, into the solemn mysteries of life in the world to come.