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THE

BIBLIOTHECA SACRA.

ARTICLE I.

THE PERSISTENCE OF FORCE; A POINT IN THE ARGUMENT OF NATURAL THEOLOGY.

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THE doctrine of the Persistence of Force, as it is among the latest, so it is considered among the surest and the most important of the results of modern science. Like every other advance in truth, it must needs have interest to the theologian; but, in the absorbing attention given to its physical relations, its theological bearings have not yet been sufficiently considered.

A certain vague recognition of the constancy of force, of a relation between the different physical forces, and, specifically, a suspicion, at least, that heat is "a mode of motion" among the particles of matter, may be found occasionally among the older philosophers. With them it was but a vague guess, like many others, which, in the minds of those familiar with nature, often become prophecies of future discovery. The matter was first brought to definite experimental test by Count Rumford at the close of the last century. He established the convertibility of mechanical motion into heat, and even determined, with a fair approximation to accuracy, the mechanical equivalent of heat. A little later these conclusions were confirmed by the experiments of Davy; but after this the subject was suffered to rest for nearly half a cen-

tury. The crucial and fundamental fact had been ascertained, but the scientific world was not yet prepared to avail itself of the fruits. Soon after 1840 the matter was taken up anew by many able investigators and has since been pursued in different countries with great skill and zeal. Seguin of France, Grove and Joule of England, Mayer of Germany, Colding of Denmark were prominent among those who first established the general doctrine of the mutual relations of the natural forces, and the subject has been closely pursued by Helmholtz, Holtzman, Faraday, Thompson, Tyndall, and many others. For the last quarter of a century it has been an established doctrine of science, and has been largely discussed theoretically and mathematically as well as experimentally.

The cardinal point of the theory is the relation of heat to mechanical motion. A definite quantitative relation between natural forces was here first established. It is a matter of sufficiently common observation that arrested, or partially arrested, motion produces heat. The leaden bullet may even melt on striking the iron target; the anvil is warmed by the repeated blows of the hammer; the journals of machinery grow hot by friction; and the hardest steel may be cut by a rapidly revolving disc of sheet iron which, pressed against it, melts its pathway through. By carefully conducted and often repeated experiments it has been shown that one pound let fall from a height of seven hundred and seventy-two feet will develop sufficient heat on striking the ground to raise one pound of water 1° F; and this is known as the mechanical equivalent of heat. It is well ascertained that motion may be wholly converted into heat; but the process cannot be reversed with the same completeness. The *a priori* presumption would be, of course, that when motion has been converted into heat, and that heat converted back again into motion, precisely the original amount of motion would be reproduced; but practically it is found that this cannot be realized.

Electricity, magnetism, chemical action, heat, mechanical

motion, are all convertible terms in the sense that any one of them may be converted into any other, and this still into another throughout the circle, although their reconvertibility is not in all cases fully practicable. To this circle (as has been shown by Le Conte and others) the animal forces also belong. Muscular action and nerve force have been abundantly proved to be correlated with the ordinary natural forces as far as it is possible to establish experimental proof in the case of a problem so complicated and encumbered with conditions of such delicacy and difficulty. By many quantitative experiments the human body has been brought into the category of mechanical engines, more exquisitely wrought, indeed, and more perfectly adjusted than any other, but still an engine, in which food is the fuel and work the result. The attempt has also been made to correlate mental action with the same natural forces, but has signally failed, because it is impossible to identify the mind with the brain, the extremest point of which natural science can take cognizance. In regard to the brain, as the especial organ of the mind's action, sufficient progress has been made, in the opinion of many physicists (though this is by no means to be considered yet as an established truth), to justify the assumption that with the development of each sensation, thought, and emotion there must be a corresponding change and expenditure of substance of the brain or nerves.

This brief summary has been presented in order that the doctrine of the correlation of forces may be clearly in view while some thoughts in regard to it are suggested which have a theological, and especially an apologetic interest. The name now preferred for the doctrine is the "persistence," rather than the "correlation" of force, the one being an obvious deduction from the other; for if no force is annihilated, but when it disappears from view is simply transformed into correlated force, then the expression "persistence of force," or "of energy," becomes a neat summary of the whole matter. In how far and in what sense this is to be considered as strictly true will be considered in the sequel.

In the meantime it may be said that nothing has contributed more to the wide diffusion and the firm tenure of the belief in a fixed order of nature than this recognition of the persistence of force. The two truths are so mutually interdependent that neither can be fully accepted apart from the other. A great step was gained when it was shown that matter was persistent: that when the oil was burned in the lamp its elements merely changed their combinations, while all continued to exist that had existed before; nothing was annihilated and nothing was created. But a far greater step was taken with the announcement of the correlative doctrine of the persistence of force; greater, not only because, as an addition to what had been taken before, it opened out a still wider view of truth, but also because it had to do with a region not so immediately under the cognizance of the senses. The general reception of these doctrines has greatly enlarged our conceptions of the unity of nature and of its fixed order — of what is commonly described as natural law; and this conception is a very fundamental one in any just theology.

But there always remains this difficulty with the enunciation of a general law from a small number of instances of its operation: we cannot doubt that these instances, however few they may be, if really understood in all their bearings, are sufficient proof of the law, for we believe in the uniformity of natural law — in other words, in the unchangeableness of the divine will — and hence that what is true in one case will be true, under precisely the same circumstances and conditions, in any other; but when the instances are few it is always difficult to be sure that in the examples before us we have only the effects of the law of which we are in search. The effects attributed to it may possibly have been modified by the action of other laws not taken into account; or, in other words, the law in question may not, in the particular cases examined, have fully worked out its legitimate and proper results. In every really scientific investigation this danger is appreciated, and the utmost care is

taken to guard against this source of error, and to isolate as perfectly as possible the phenomena to be examined; but the difficulties of thorough scientific experiment are great, and our knowledge even of familiar things is limited. Hence it happens that almost every result needs to be tested under diverse circumstances and by different investigators, and confidence is not established in the conclusions reached until this has been done. When this has been accomplished, as it has been to a good degree in the case of the persistence of force, the establishment of a general law is recognized; but even then it is hazardous to assume too soon or too positively that this law is fully understood in all its completeness. Disagreements, more or less important, always exist between theory and experiment; and when the mean of a large number of observations accords with the theory, these differences are fairly attributed to the unavoidable errors of observation. But confidence in this explanation must be in proportion to the number of observations, the breadth of their scope, and the length of time in which they have been subjected to the questionings of scientific reasoners. For example: the Ptolemaic system did very well for astronomy, and there was reason for thinking it the true account of the relations of the heavenly bodies until observations had been greatly multiplied; so, too, the phlogiston theory held its place in chemistry until experiments had become too numerous to admit of explanation by its means. The evidence of truths in natural science is thus assimilated in character to moral rather than to demonstrative evidence, in that it consists for the most part of an accumulation of probabilities; but with this important difference, that when certain facts have once been sufficiently established by observation, they may become the basis of mathematical reasoning to others. The foundation of all, however, is in observation, and these observations are trustworthy in proportion to their number and the care with which they have been made. The basis for mathematical reasoning from them cannot be perfect until the observations themselves have not only become perfectly

accurate, but have embraced absolutely all the facts entering into the calculation. Thus it comes about that while many natural laws have been established beyond peradventure, it has yet been well said even of these that they are, in a certain sense, *inexact;*[1] they form a general statement, as it were, of the norm of nature's action, but they are never found to correspond precisely with the actual phenomena of the world. The want of correspondence is due only to our iusufficient knowledge, and every advance in knowledge and every wider generalization brings the law and the fact into closer harmony. Still, even of a law as long and as thoroughly investigated as that of gravity it remains true that there are certain residual phenomena left unexplained. Uranus did not move in its orbit as it should have done until Neptune was discovered; even now Mercury, in its transit, does not make contact at precisely the appointed second. The supposed discovery of intra-Mercurial planets, if confirmed by further researches of astronomers, will introduce fresh elements into their calculations. It cannot be hoped that difficulties will be entirely removed until knowledge is made perfect.

These facts have been called to mind in this connection because such difficulties must press particularly upon the treatment of those laws which have been most recently discovered, and the phenomena of which have been therefore subjected to the least perfect and continuous investigation under varying aspects. It is not very long since La Place established upon a mathematical basis the permanence of the solar system; more recently Le Verrier, by using some terms of a higher order which had been neglected in the equations of La Place, demonstrated the unreliability of this conclusion. Probably no mathematician would now assume that all the necessary data were well enough known to allow of the determination of this question upon mathematical grounds alone. The reasoning might be faultless, but the facts of observation, which must form its basis, are more or less uncertain. If

[1] Cooke's Chemical Physics, sec. 165, pp. 300, 301.

this be true of a question so long and attentively investigated, it must be true *a fortiori* of one of the most recently discovered of all the great laws of nature.

The first and most obvious inference from the doctrine of the correlation of forces was this: Since all force which disappears under one form reappears under another, the sum total of force in the universe, like the sum total of matter, is always constant. The doctrine has been, and is still, often stated in precisely this form: there is no creation of force and there is no annihilation of force, but merely transformations take place which leave the total energy of the universe unchanged. The common effect of this statement upon men's minds is to satisfy them of the permanence of substantially the present state of things in the universe viewed as a whole. There are evidently vast cycles of change in the existing order; but the sum total of matter and of force being always the same, there is on the whole a perfect balance, and however the pendulum may swing, now to one side and now to the other, it must always return through the centre in its appointed time.

But this inference has been proved to be untrue by a more careful scientific investigation of the facts. Clausius has subjected the theory to a rigid mathematical analysis and has been led thereby to a different conclusion. He found himself, at the outset, obliged to distinguish between processes which are simply and entirely reversible and those which are in part irreversible. Motion may be wholly converted into heat, but heat cannot be wholly reconverted into motion. In all experiments thus far attempted there is a certain inconvertible residuum, and this having been the case in a great variety of experiments and under a great variety of circumstances, Clausius and his opponents are alike obliged to accept it as a part of the natural law. Now, since this is the result of the operations of nature, incessantly going on upon a vast scale, there must ensue a disturbance of its existing condition. "A general and prevailing tendency in nature to changes of a certain character is indicated by these

principles. . . . . If in the universe cases continually occur, through friction or other similar impediments to motion, of the conversion into heat, that is to say, into molecular motions, of the motions with which large masses are animated, and which are due, either actually or conceivably, to work done by natural forces; and if, further, heat always strives to alter its distribution, so that existing differences of temperature may be cancelled, then the universe must gradually be approaching more and more to the condition in which forces can produce no further motion, and differences of temperature can no longer exist."[1] It will be observed that this conclusion is a general one, embracing the whole universe in its scope; all motion in the ordinary sense of that word, that is, all molar motion, tends to be converted into molecular motion, or heat, and heat tends to an equal universal distribution. The tendency, then, not of any part, but of the whole, universe is to a motionless condition of uniform temperature.

To the same purpose he shows in another Memoir, as a necessary deduction from his second fundamental theorem, that "Transformations occurring in nature may take place in a certain direction, which I have assumed as positive, by themselves, that is, without compensation; but that in the opposite, and consequently negative direction, they can only take place in such a manner as to be compensated by simultaneously occurring positive transformations. . . . . In fact, if in all the changes of condition occurring in the universe the transformations in one definite direction exceed in magnitude those in the opposite direction, the entire condition of the universe must always continue to change in that first direction, and the universe must consequently approach incessantly to a limiting condition."[2] Clausius had worked out his theorems mathematically without observing these

[1] The Mechanical Theory of Heat. By R. Clausius (Eng. trans.), 8th Memoir, p. 290.

[2] Ibid., 9th Memoir, p. 364. See also p. 365; also 6th Memoir, pp. 224, 245, and note on p. 247.

conclusions resulting from them in regard to the universe; his attention was first called to them by Sir W. Thompson.[1]

The conclusions themselves, however, were too important and too obviously at variance with certain popular theories to pass unchallenged. An attempt was made to do away with their effect by Rankine.[2] He fully admitted the mathematical certainty of the process "whereby mechanical energy becomes more and more dissipated," but suggested that there might also be an opposite effect "whereby mechanical energy may be again concentrated and stored up in individual masses." Something will be said further on of the process by which he conceived this might be possible; meantime suffice it to say that Clausius has shown mathematically that it is theoretically impossible.[3] If the hypothesis be analyzed it will be found equivalent to saying that in some part of the universe the laws of nature, as we know them, are reversed.

These conclusions of Clausius are cited not because they have been proved to be absolutely true (for there may well exist a doubt whether even so eminent a mathematician has succeeded in embracing all the necessary terms in his calculations); but because they show this: that the profoundest mathematical investigations yet made on the subject lead to a very different result from that which is popularly supposed. In so far, however, as these conclusions are reliable — and they are the best yet attained — they go to show that with the gradual transformation of all motion into heat, accompanied with the universal distribution and equalization of the latter, the universe that now is, is a very different thing from the universe of either the past or the future.

Let us turn now from this mathematical view of the subject to another which has been popularized in the philosophy of Herbert Spencer. All must admit the general truth of his fundamental position, that the universal tendency of nature,

[1] Phil. Mag., S. 4. Vol. iv. p. 304, as quoted by Clausius, ubi sup.
[2] Ibid., Vol. iv. p. 358.
[3] Mechanical Theory of Heat, 8th Memoir.

so far as it has come under human observation, is to proceed from the general to the special, from the homogeneous to the heterogeneous. Whatever may be the true philosophy of this fact, the fact itself is an unquestionable one. In this process, which is a process of integration, there is and must necessarily be always and everywhere (as Mr. Spencer shows) a dissipation of force. Take a particular and obvious illustration of the general principle which, by a change of terms, might be made to apply to any other example. The sun of our system is continually radiating into space an enormous amount of energy. The part of this intercepted by the earth is great indeed in its value in the economy of the earth, being the chief — almost the sole — factor in all terrestrial dynamics; but, in comparison to the whole amount radiated, is as small as the section of the earth in comparison with the surface of that vast sphere of which the sun is the centre and the earth's distance from it the radius. The same thing may be said of each of the other planets in proportion to their size and distance. The amount of the sun's energy absorbed by them all is exceedingly small in comparison with the whole amount radiated. It is estimated that only one two-thousand-millionth of the sun's rays is intercepted by the earth, and only twelve times that amount by all the bodies of the solar system taken together; and even of this a fraction is reflected from their surfaces and another portion is radiated off into space. In the same way the fixed stars, the suns of other systems, and the nebulae also, are all radiating into space, hourly and momentarily, amounts of energy which the imagination vainly essays to comprehend. Very little of this is in any case absorbed by any known bodies. What then becomes of it?

Perhaps the most common conception, somewhat vaguely held, is that all space is so filled with celestial bodies that ultimately the whole sphere of radiation is occupied, and thus in the end all radiated energy is absorbed. Although very little of the energy radiated from any particular body is taken up by any other one body, yet the number of bodies is

so countless that, taken together, they absorb the whole; and, on the other hand, each single body receives a fraction, however small, of the radiations from all the others. Thus the balance is, on the whole, kept up; nothing is lost, and nothing gained. But the existence of celestial bodies thus covering the whole sphere of radiation is purely imaginary. It is not only destitute of any tittle of evidence; but such facts of astronomy as we know seem to be against it. Every enlargement of the power of the telescope has indeed brought within the range of vision multitudes of new stars, but at such distances that their size, however great absolutely, bears no appreciable proportion to the surface of the sphere in which they lie. Astronomy further indicates that the celestial bodies are not distributed uniformly through space, but are clustered in certain definite directions. Setting aside, however, all these considerations, a moments reflection will show the impossibility of the hypothesis. Energy is radiated from all the bodies of the universe in all directions. If the number of bodies in the universe is finite, then some of them must be the outermost, with no others beyond; but from these outermost bodies outward radiations must still go on. They must be the means of conveying away from the universe a certain continual stream of energy, and the sum total of the remainder must be always diminishing. The suggestions of Rankine to avoid this conclusion will be considered further on.

This conclusion may indeed be avoided by supposing the number of bodies in the universe to be really infinite. In that case, at any point whatever the radiating bodies beyond will be equal to those on this side, the number above will be equal to those below. The equalizing tendency of radiating energy could never bring the universe to a state of motionless equilibrium at a uniform temperature, because, the universe being infinite, infinite time would be required to produce the effect, and hence the universe would be eternal. But such a supposition is a mere plunge into that sea of vagueness and uncertainty which always attends the attempt to

combine the incommensurable terms of the finite and the infinite. At best it would be a purely imaginary hypothesis, and one of great complexity; but we look upon the bare statement of an absolutely infinite number of finite worlds as a contradiction of terms, not in any wise entitled to enter into the discussion of the subject. The attributes of infinity necessarily belong together, and an enumeration of parts is inconsistent with them; while, on the other hand, limitation is an essential quality of matter, and the inconsistency of this with infinity cannot be removed by mere multiplication.

Infinity, however, is apt to be popularly confounded with indefiniteness; and hence what would be true of a really infinite number — if this were possible — is supposed to be true of an indefinite number. This is far from being the case; for infinity and indefiniteness differ not in degree, but in kind. Now, if the number of worlds be only indefinite, however great, they have a limit. The imagination may become weary and thought exhausted before that limit is reached; but radiation is not, and will still go on beyond. The question then recurs: What becomes of the energy radiated out beyond the last celestial body? Plainly, if it is lost to the universe, the doctrine of the persistence of force, as commonly understood, can no longer be maintained in its absolute sense. The difficulty has forced itself upon the attention of those who have examined the subject, and several hypotheses have been suggested for its solution. Mr. Spencer insists much upon the dissipation of force in a forming world, and he also supposes its ultimate reconcentration upon a dissolving world; but he gives no hint directly of the way in which this may be accomplished. He tells us that the process of integration and of consequent dissipation of force, when it shall have reached its ultimate result, will in some way, which he does not undertake to explain, be replaced by the opposite process of disintegration and concentration of force. Such a supposition is, as already said, in opposition to the conclusions of Clausius, based upon the mechanical theory of heat. Those conclusions embrace in

their nature all material things, and require the equal distribution, and not the reconcentration, of dissipated energy. But, aside from this, the hypothesis of Spencer makes necessary the supposition of some reservoir of force where the dissipated energy may be stored until it can again be returned and be made available. The theory of the existence of more than one universe has been thought to meet this necessity; different universes being in reciprocal conditions, one receiving what is dissipated from the other. Thus to meet the difficulty we are brought again to an hypothesis which is purely imaginary, which can lay claim to no shadow of evidence in its support, and one which is in itself so complicated as to be extremely suspicious.

But to appreciate fairly this hypothesis there is need of the exercise of a little of that scientific imagination which Mr. Tyndall considers so important. Let it be attempted to realize in thought the position of such universes in space. The notion of the reflection of energy will be considered presently. Setting this aside now, and taking the simplest form of the hypothesis, let it be supposed that there are just two universes, the one radiating energy and the other receiving the energy radiated. The dissipated force is dissipated equally in all directions, and therefore, if it is to be received by another universe, this second universe must necessarily enclose the dissipating one as an outer shell or sphere. But even this conception does not meet the requirements of the case. The outer universe must also radiate its energy outwardly as well as inwardly, and hence must itself be enclosed by another universe beyond, and so on *ad infinitum*. We have come back again to the old point of an absolute infinity of worlds, and so have no better solution of the difficulty than before.

Another suggestion to meet the difficulty is, that space being infinite, the energy radiated is neither lost nor annihilated, but may go on radiating forever. However far it has moved in the untold ages of the past, there is still an infinite beyond, the bounds of which it can never reach, for there are

no bounds. This is only a solution in words, and is of no real value. As far as the universe which is subject to our investigation, or even to our speculation, is concerned, it is only another form of saying that the dissipated energy is lost. It is gone from our universe never to return, and we have merely confessed our ignorance as to what becomes of it. It is not unlike Sam Weller's account of the end of the post-boys and the old donkeys: "They gets on the donkeys and rides off." Seriously, for anything except a mere verbal technicality, this is a denial of the persistence of force. As far as our cosmos is concerned, the energy is gone when it has passed away from it to an infinite distance. Mr. Spencer assures us that the notion of the annihilation of force is unthinkable, and therefore untrue. It has nevertheless been thought by all the past generations of men, and continues to be by the immense mass of the present generation. The notion of infinite space is also "unthinkable" in a certain sense, as everything is unthinkable to the finite mind when attempting to comprehend the infinite. But quite apart from all such considerations the practical result of this hypothesis must be that the universe with which we have to do is undergoing a gradual but complete transformation by the dissipation of its energy to parts unknown.

There are weightier reasons for believing in the persistence of force than the assumed unthinkableness of its contradiction; but none of the theories yet examined can suffice to reconcile our belief with the patent facts of nature. Another hypothesis has been put forth with some pretension, and has gained some currency, based upon the assumption that the material universe is finite and surrounded by absolutely empty space. As this exhausts all the accounts of the matter from the materialistic point of view, it may be well to examine this also.

On this hypothesis all dissipated energy must, sooner or later, reach the bounds of its conducting medium, and then can go no further, for there is nothing into which it can pass; from the surrounding wall of nothingness it will be reflected

back. This hypothesis may seem too purely imaginary, and even as an imagination too wonderful to require serious consideration; nevertheless, since it is the last resort hitherto proposed of materialistic philosophy for dealing with the manifest fact of the dissipation of energy from the known universe, it requires to be examined fairly. It will be found encumbered with difficulties, the statement of which may be a little tedious; but this is necessary for the appreciation of the hypothesis. It is the hypothesis of Rankine, already referred to, and has apparently formed the basis of much of current philosophical literature. Clausius has carefully examined it and shown it to be impossible on mathematical grounds; it is proposed to look at it here from another point of view. To have it clearly before the mind it is stated in Rankine's own words as quoted by Clausius.[1] Rankine had already spoken of the production of heat by the work of natural forces, of the tendency of heat so to distribute itself among bodies as to equalize their temperature, and of the further tendency of all bodies in the universe continually to give off more and more heat to the ether which pervades space; he then continues, "Let it now be supposed that, in all directions around the visible world, the interstellar medium has bounds beyond which there is empty space.

"If this conjecture be true, then on reaching those bounds the radiant heat of the world will be totally reflected, and will ultimately be reconstituted into foci. At each of these foci the intensity may be expected to be such that, should a star (being at that period an extinct mass of inert compounds) in the course of its motions arrive at that point of space, it will be varporized and resolved into its elements, a store of chemical power being thus reproduced at the expense of a corresponding amount of radiant heat.

"Thus it appears that, although from what we can see of the known world, its condition seems to tend continually towards the equable diffusion, in the form of radiant heat, of all physical energy, the extinction of the stars, and the

[1] Mechanical Theory of Heat (8th Memoir), p. 291.

cessation of all phenomēna, yet the world, as now created, may possibly be provided within itself with the means of reconcentrating its physical energies and renewing its activity and life." Rankine having enunciated this hypothesis, Clausius devoted a special memoir to an examination of the concentration of rays of light and heat, and in this, as already said, he has shown that Rankine's theory is mathematically impossible. Perhaps the same result may be obtained from more general considerations without attempting to follow the equaticns of Clausius.

In the first place, it is essential to the theory of Rankine that his foci should be limited in number, since otherwise the energy diffused through space could not be effectively concentrated anywhere. This makes necessary the further supposition that the supposed reflecting boundaries of energy have a definite shape relatively to these foci; in fact this would be a part of the definition of the foci themselves. It is further necessary that all the radiating matter of the universe should be in certain definite positions in relation to these bounds, in order that their radiated energy may, by reflection, be reconcentrated in these foci. For all this there is, of course, not only no shadow of evidence, but, in view of the fact that all bodies of which we know are in motion relatively to one another, it is inconceivable. The radiated energy of the solar system, or of any other system, which might conceivably be reflected to a certain focus at one moment, could not be gathered there at another; for the position of the radiating bodies would have changed, and if the foci be supposed infinitely numerous, there will remain no longer a concentration, but only an equal diffusion of the radiated energy.

But time is as important a factor as form in the reconcentration of the radiated energy. Hence these supposed boundaries must be at such an inconceivable distance that the whole duration of the dissipation of energy would only suffice for the journey of light to those boundaries and back again to one of these foci in order save the earliest dissipated

force, and, at the same time, so near that the force last dissipated would only have time to reach the same point. These are manifestly contradictory assumptions, and yet are both necessary to the reconcentration of energy at any point, unless there be always at the focus some body on which that energy can be concentrated. This latter supposition must be dismissed as inconsistent with the high probability, at least, that all bodies in the universe are in motion; but even if it were not so, it would only amount to a perpetual concentration of energy upon those particular bodies which remained permanently at the foci, and in these the whole force of the universe would tend to become permanently absorbed. Bodies so placed, and permanently at rest, would mutually dissipate and mutually receive energy until an equilibrium was reached, and we should then have motionless bodies at the foci of space, having each a permanent totality of energy. This would be a very different universe from anything of which we know, and from anything which the researches of science indicate as probable in the future, and would imply a final condition of the universe in the state of several permanent nebulae. Apart from such suppositions, it is plain that the reflected energy would be continually passing and repassing through the foci, and there could never be a concentration at those points of anything more than the energy which might be, at any particular moment, actually *in transitu;* all the rest would still be in a state of dissipation.

But the element of time comes into the hypothesis also in another way. The theory requires that some star, at a time when it has become "an extinct mass of inert compounds," should pass through the particular point in space occupied by one of the supposed foci. In view of the relative dimensions of the supposed universe and of the stars, it would be difficult to calculate the fraction which should express the probability of such a contingency.

This theory appears, therefore, to be untenable, independently of Clausius' demonstration of its mathematical impossibility, and independently also of any particular form which

might be assigned to the ether-filled finite universe. Were it worth while, additional evidence might be brought against it by considering the effect of different possible forms; but this is unnecessary. The theory will not enable us to conceive of the persistence of energy forever, by turns in process of dissipation during the integration of the universe, and of reconcentration during its disintegration. Some form of this theory appears to have been in the mind of Mr. Spencer, but he cannot be charged with it in the absence of any definite reference thereto.

Since, then, we are thus compelled to set aside every materialistic explanation yet offered of the great and patent fact of the dissipation of force, and yet receiving, at least in a general way, the doctrine of the persistence of force, what remains to be said? The fact of the dissipation, and that on an enormous scale, no man can deny; but all the analogies of nature, as well as all confidence in the invariability of natural law, lead us to deny that, if this force is to be considered as an entity, it can ever be annihilated. Is the paradox insoluble? We believe it may be resolved by the same clue which is the ultimate resort in all the other enigmas of our condition, by looking to the Infinite.

Let us take a somewhat parallel difficulty in a matter easily within the scope of our observation and our science. The water is constantly evaporated from the surface of the ocean, lakes, rivers, and land; yet the supply continues on the whole undiminished, and we ask where it comes from. It is traced to its source in the condensation of the same vapors which have come from this evaporation, and which thus returns that which has been taken in endless round. To accomplish the process force is indeed required; but this force too is restored, apparently in full measure, though nothing is hereby learned in regard to the original source either of the matter or of the force by which it is energized. That question, however, presses upon us when we consider the dissipation of force from the universe. Here we are compelled to ask both what can be the source from which

this supply of energy proceeds and whither it goes. It does not matter that the amount now stored in the universe may be diminishing — that the present supply does not equal the expenditure; it must all ultimately have had a source, and, if it be not annihilated, it must all ultimately be somehow treasured up. Our physics do not solve these questions. Mechanical motion may be transformed into heat, and heat into chemical action, and chemical action into electricity, and electrity into magnetism, and magnetism again, in great part at least, into mechanical motion, in almost endless round, embracing in the circle a much wider range of the forms of force than it is here necessary to name. But the reconvertibility is not perfect. There is a residue in the process, and meantime the energy of the universe is continually passing away. The circle, if it were perfect, could not have been self-evolved, nor, as it is, can it be self-sustaining. If it ever had been exactly balanced, the incessant dissipation of force must have disturbed that balance and have required instant and unending adjustment. The universe, supposing for the moment that it could itself be regarded as eternal, could have been supplied with no finite reservoir of energy which would not, during its eternal existence, have become exhausted; and if the universe be not eternal then both it and its energy are to be accounted for, since they could not have originated themselves.

Again: the fundamental laws of motion require that a body in motion, free from all external influence, should continue to move on in a straight line forever; and that a body at rest, free from external influence, should remain at rest forever. No doubt it is assumed by some philosophers that motion is an original, inherent property of matter; but this is an assumption merely, and has no other claim to acceptance than that the two facts, matter and motion, require to be accounted for. It is not to be forgotten that they are *two* facts; that matter may be conceived of as without motion, and that therefore an hypothesis which accounts for matter will not necessarily account for motion. Motion is not a

necessary property of matter; if it be an original property it is because it has been made so by some reason or power external to matter itself. If, then, the statement be true that all forms of energy may be ultimately resolved into modes of motion, it follows that the source of energy must also be external to the material universe. Moreover, neither observation nor speculation give us any intimation of the existence of abstract force apart from anything of which it is a property or from which it proceeds. Thus again it appears that it must have been added to matter from without. Whence, then, in its ultimate origin, does motion, or any other form of energy come?

Natural science, in as far as it confines itself to nature, can only answer this question by saying that its source is outside of and beyond nature. So it has been answered. Tyndall and others describe evolution as taking place under "a Power forever inscrutable to the human intellect." Herbert Spencer bases all his philosophy upon the existence of an "Unknowable." It does not matter how little or how much the philosophy of nescience may undertake to tell us of this unknowable power; it is apt, when its statements are analyzed, to tell something more than it intended. But this, for the present purpose, is of no consequence; the point is, that it distinctly recognizes the source of all force or energy as outside of that nature which is immediately subject to the scrutiny of human observation. Here is the first step in the true and only solution of the problem: The energy in nature proceeds from a source outside of nature. So far there seems to be a tendency to a general agreement among men of every school of thought, with the exception of the pantheists. The pantheist makes the cosmos itself the source of its own energy; but this is inadmissible in the light of the problem here considered. For, if terms are to be used to which it is hard to attach any definite meaning, and we were to say that the energy of the universe comes from an infinite spirit of the universe which is the universe itself, we should only be involving ourselves in a palpable contradiction, unless we were

also to maintain that the universe itself is really infinite. This proposition has already been considered and set aside. For any universe less than one absolutely infinite the law of the dissipation of force requires some higher ultimate source of its energy. Pantheism, therefore, fails to solve the difficulty.

Of the source of energy this much is certainly known: it must be infinite. For, if the universe be eternal, it requires an inexhaustible (which is an infinite) source for its energy. And if the universe be not eternal then it is a necessity of thought that it should have proceeded from somewhat which, in its ultimate origin, is self-existent and eternal. It is only necessary to attribute to this eternal source the character of a Being, and we have the final hypothesis which we believe solves, and alone can solve, the difficulties before us. Of course this is not to be understood in the sense that the energy of the universe is itself that Being (which would bring us back again to pantheism), but that it proceeds from him in the sense that he wills it and causes it, and without his will it is not. The facts here considered, taken alone, may not suffice to prove the truth of this hypothesis, but they do furnish two reasons for its probability: first, no other tenable hypothesis is suggested; and, secondly, it is, by many degrees, the simplest hypothesis, and is therefore entitled to be received until it can be disproved. When associated with such other evidences as that of design, or orderly arrangement of the universe, the proof that this infinite source of energy is a Being becomes very strong; but the present argument can deal only with the facts of force. The two admitted facts of its persistence and its dissipation, seemingly in contradiction, are not reconciled satisfactorily by the hypothesis of the reflection and reconcentration of energy, nor by any supposition of correlated universes, nor by any other physical theory. Pantheism also fails to afford a solution because it so identifies the universe with God that it requires the universe itself to be absolutely infinite in order to satisfy the conditions of the problem, and this requirement is inadmissible. The

hypothesis of an infinite, self-conscious Being alone meets the difficulty, and this does fully meet it. There can be no exhaustion of energy while he wills that it shall be; and there can be no question of what becomes of dissipated energy when he wills that it shall not be. In other words, under this hypothesis energy is not to be regarded as an independent entity; it is simply, always, and instantly an effect of the divine activity. It is not that activity itself, as the pantheist would have us suppose, but an effect coming into existence with the manifestation of that activity in certain forms, and ceasing whenever and in so far as that manifestation of the divine activity ceases. Hence it follows that the cause of what we call the persistence of energy is simply that, in the limited range of physical changes which come under our observation, the effects of the divine activity are constant. But the constancy of the effect depends upon the constancy of the cause, and we have no power to assert that these particular manifestations will continue unchanged forever. We have no occasion to determine what becomes of the dissipated energy; when and where the manifestation of divine activity on material things ceases, then physical energy ceases. It is no longer correlated or transformed; it ceases. It is absolutely dependent upon the divine will.

This hypothesis is utterly inconsistent with that view of nature which supposes it to have been endued at the start with a given amount of energy, and then allowed to go on under its constant dissipation until the stock shall be exhausted. Such a supposition would again make force something in itself beyond a mere effect, and would renew the question, what becomes of the dissipated energy. It would further require that the universe should tend to exhaustion until the original source of its energy should again interpose. The hypothesis is rather that force or energy itself is, as already said, but an effect of the manifestation of his activity; all things are by him and for him; he is not only before all things, but by him all things consist, and he is all in all.

When we speak of this source of energy as a Being we do

but use a Saxon expression which in its Latinized form is only existence; and the fact of the existence of a source of energy must be admitted by all but the extremest Pantheist. The Saxon form of the expression, however, is associated in our minds with certain other notions which, for want of any better words, we are fain to express by the terms "self-consciousness" and "personality," and we apply the term to the Source of nature because these things are seen to belong to him by other evidences, of which this is not the place to speak. But even apart from those other evidences, the same truth is really involved in the very facts of the persistence and the dissipation of energy; for we have seen that the only solution of this paradox is in an eternal will, which involves all that we mean by the term personality.

It is no answer to this argument to say that possibly further investigations may bring to light facts of which we are at present ignorant, to show that nature contains within itself some now unknown provision for the reconcentration of its dissipated energy. If this could be so, the argument would yet remain valid as far as the present state of knowledge is concerned, and could scarcely be met by the argument *ex ignoto;* but the attempt has been made to show that it cannot be so. Both the observed facts of nature and the general theory of evolution expressly teach that there is and there must be an absolute dissipation of force from an integrating universe as a whole. The fact is recognized on all sides, alike by scientists and philosophers, and requires to be accounted for. We believe that, in the nature of things, there can be no way of accounting for it on merely materialistic grounds.

At the same time, while the fact must always remain that the ultimate source of all energy is a Divine Being, it remains possible, and even probable, that further knowledge will yet be obtained of its methods. All physical modes of its reconcentration hitherto proposed fail to meet the requirements of the problem; but some method, nearer the truth, may hereafter come to be known. If so, another step will be gained in the knowledge of the modes of the divine activity; but

this would not tend to make God a part of nature. The evidence would remain unaffected that the ultimate Source and the Sustainer of all energy must be outside of nature. It would only show more perfectly how nature proceeds from God, and how all its laws are but the expression of his immutable will. When the energy of the universe is thus conceived of, as the effect of the immediate activity of God, the study of nature acquires a new and higher significance, and its importance as an aid in the study of revelation is made clear. The scientist in seeking to discover the laws of nature and the secrets of energy is, consciously or unconsciously, studying the expression of the Almighty Will and the effects of his activity in the visible universe.

It is hardly necessary to add that this conclusion from the consideration of the persistence of force is one which, in some shape or other, lies at the basis of several forms of thought which, at various times and in various lands, have proved attractive to intelligent men. It is the essential truth, the perversion of which is seen in pantheism; and this truth, therefore, misunderstood, has been the groundwork of all pantheistic religions. Yet it is broadly distinguished from pantheism in that it refuses to confound God with nature; but rather, by its fundamental position, requires that he should be apart from and above nature. It is the essential truth which is but dimly groped after in the expression *animus mundi*. Divested of all pantheistic error it is the foundation of certain higher teaching not of our working out. That teaching has been but imperfectly understood in the past, and can be but imperfectly grasped even now; yet the progress of scientific thought and research is ever helping on to its better understanding. The old rationalistic idea that God constructed the universe as a machine and then left it to itself to work out its own results, is scattered to the winds by such truths as we have been considering. These teach us of the immanence of God in his works, and bring us back from all secondary causes to the conception of the old Hebrew poets and sages to whom everything was God's doing. They

show us that, not by any figure, but in very reality, "In him we live and move and have our being." He is above nature and below it, without it and within it, yet never a part of it. He is not nature, but nature is from him and subsists by him.

"Super cuncta, subter cuncta;
Extra cuncta, intra cuncta;
Intra cuncta, nec inclusus;
Extra cuncta, nec exclusus;
Super cuncta, nec elatus;
Subter cuncta, nec substratus."

ARTICLE II.

WHAT IS UNITARIANISM?

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THE adage that like draws to like has notable exceptions, both in the world of matter and in the world of mind. The factions in a party or sect are sometimes more bitter against each other than against their common opponents. When a man assents to most of the propositions which we hold of highest importance, and thus gives us proof of what we consider his good sense, we are surprised, and perhaps annoyed, at his differing from our views at all. It is, therefore, a delicate task for a person to attempt a description of the denomination to which he belongs; he must inevitably fail to satisfy some one of the wings of his sect. It is, perhaps, especially difficult to do justice to the Unitarians, because that denomination in New England carried, for many decades, the motto: Liberty, Holiness, Love. By putting liberty first they insured the greatest variety and individuality of opinion. This is, indeed, frequently affirmed by members of the denomination to be its distinguishing characteristic. They have no creed; and their opponents sometimes sarcastically add, no opinions.