Coupe ends his pamphlet 'On Casuistry':

F.M. Every intentional effort to encase the ego makes it all the more virulent. Every attempt at limitation is, with more or less subtlety turned into a defence. I should not be surprised, indeed, if Mr Coupe is not striving to make—or shall we not say, to make out—a case for his own ego and, like the rest of us, can't quite manage it.

Although his work is done, his task fulfilled, so that he may be at rest, I should be sorry to think that such an ironic and delightful philosopher's passing should be ignored and his words forgotten.

J. B. Pick.

STATISTICAL TRUTH [1]

The natural sciences, especially physical science, have made very great strides in this century. I refer especially to Einstein's theory of relativity and the quantum theory. There can be no doubt that these theories are valid; that is to say, either they are true, or they are abstractions bearing such a relation to truth that they systematise observations and lead to correct predictions. Among scientists theories are no longer regarded as true but have come to be recognised as abstractions, as a result of the teachings of Mach, but even more so as a result of the impact of relativity and quantum theory. The naïve realism of Newtonian physics is dead. But at the same time nobody has succeeded in building up a system of natural philosophy showing exactly how theoretical science is related to reality. The effect of this has been, on the one hand, to move scientists towards scepticism or even a kind of Kantian idealism, as in the case of the late Sir Arthur Eddington, doubting or denying the validity of the concepts of reality and truth. On the other hand it has prevented the Thomist arguments for the existence of God from resting upon the conclusions of natural science through the mediation of natural philosophy. Instead they rest upon the nature of common-sense. Indeed, there is another way of stating that at present there exists no system of natural philosophy. If there were, the flagrant and absurd contradictions between natural science and common-sense knowledge would be resolved without in any way destroying either common-sense or natural science. Now one of the very important causes of such conflict arises from the absence of an explanation of the source and validity of the statistical method. In default, the statistical method is accepted on observational grounds alone and so, standing

1 The text of a paper read to the Newman Association during the Summer School at Stonyhurst College.

as an absolute in its own right, it appears that knowledge is of probabilities only, never of certainties. On this account I have elected to discuss Statistics, especially in relation to physical science.

Under the title of 'Statistical Truth' the problem I wish to discuss is that of the source and justification of the statistical method in natural science. I propose to show that this method as applied to natural events, involves an assumption in regard to them. I then propose to examine the method as it is employed in modern physics. However, before embarking upon these questions it is imperative to give some general indication regarding the theory of knowledge governing the argument to be developed. I am of the opinion that to affirm the reality of oneself and of other things, the notions of oneself and of other things must be judgments of the spontaneous reason. (In scholastic terminology judgments of the spontaneous reason are judgments *in actu exercito* as distinct from explicit, reflective judgments *in actu signato*.) It is clearly outside the scope of this paper to defend this position by showing that denial of it leads to idealism or scepticism. It is therefore proposed to assume here the reality of oneself and of other things as rational judgments. This assumption implies that the notion of Nature is rational, that is to say, according to the initiative and spontaneous principles of reason. In particular it follows that the principle of causality must be valid for Nature. This fundamental affirmation is in marked contrast to the usual empiricist opinion that the principle of causality is derived from experience of natural things. Indeed, the problem that I am attempting is to show that modern physical theory, quantum theory, does not contradict the principle of causality. If, on the contrary, the principle of causality is held to be a wide generalisation from experience, then there is no reason for affirming it of the individual subsensible actions of molecular physics. The emergence of such an apparent limitation to the principle of causality, with its evident bearing upon wider problems, has excited a general interest. It is, however, necessary to make it quite clear that I am attempting to show that molecular physics is not inconsistent with affirming the principle of causality as valid throughout Nature. I am *not* attempting to show that the principle of causality can be adduced from molecular physics. There is no doubt that it cannot be.

A complete knowledge of the causes of an event leads to correct prediction of its impending occurrence or non-occurrence. However, in those cases in which the occurrence or non-occurrence of an event is determined by a multiplicity of small causes, as in the throwing of dice, it is neither possible to control nor to measure all the causes and thus it is impossible to make predictions. It is however a fact of experience that over numerous trials possible events actually occur in frequencies tending to definite proportions as the number of trials is increased. A knowledge of such distributions of frequency between possible events represents a knowledge of the probability of occurrence of each event. Such a knowledge leads to practically correct predictions over a sufficient number of trials. Thus, the statistical method must be employed to achieve whatever prediction is possible in the case of events for which the exact causes are unknown. The reason why the method has come to occupy a dominant position in physical science arises from the fact that events of all kinds have been shewn to be due each to the sum of a multiplicity of subsensile discrete actions. At one time gravitation, heat conduction, sound, radiation and light were all regarded as continuous actions produced by sensible agents. In consequence of the atomic theory of matter and the kinetic theory of heat, heat conduction and sound waves became accepted as the resultant of innumerable molecular encounters. Although individual molecular encounters could not be observed, Clark Maxwell and others shewed that the statistical method enabled the laws of heat transference to be deduced, especially in the case of gases. From about the beginning of this century, as a result of Planck's theory for the energy distribution in radiation from black bodies, the discrete and subsensible nature of individual radiations has been accepted by physicists, while gravitation has been put outside the scheme of ordinary actions by Einstein's general theory of relativity. Thus all the modes of sensible physical action are now believed to be each the sum of many subsensible actions, gravitation itself hardly being regarded as a physical action at all. An evident consequence of the subsensible nature of individual actions is that the statistical method must now be employed almost throughout the domain of physics. It will therefore be convenient to use the term 'classical physics' for physical science from the time of Descartes until about 1900, reserving the term 'modern physics' for physical science since the advent of relativity and the quantum theory.

As stated earlier, in applying the statistical method to natural events there is an underlying assumption. Take for instance the case of throwing dice: it is implicitly assumed that each of the possible events is equally probable, apart from the effect of causes, such as bias, producing deviations from the equality of probability. Looking at the result of throws from the non-statistical standpoint, each is determined by a multiplicity of causes. There is no apparent reason in the nature of things why the ratios of the number of each possible event actually recorded over many trial throws should tend to unity for unbiassed dice and to other definite values for biassed dice. Bias and other causes of deviation do account for the difference of probability of events between biassed and unbiassed dice. That in unbiassed dice each possible event is equally probable is an assumption, suggested perhaps by our innate love of regularity and order, experimentally verified and justified.

To consider a more important example, take the case of two similar things, A and B, heated by the sun. Provided they are equidistant from the sun their temperatures would be equal. Yet their measurable temperatures are the resultant of innumerable radiator-receptor actions between the sun and the things. To account for the sum of such actions in A equalling that in B it is sufficient to make the hypothesis that the sun is equally likely to radiate in every direction. From this hypothesis it may be further deduced that the amount of radiation from the sun varies inversely as the square of the distance from it. The experimental verification of this deduction, substantiating the original hypothesis of an equal chance of radiation in every direction, completes the classical method of 'induction, deduction and verification'. It nevertheless remains that the hypothesis of an equal chance of radiation in every direction requires an explanation. The need of such an explanation does not arise for the experientialists who, accepting Nature as a primary datum, claim that first principles are generalisations from experience. For these hypotheses of equal chance may be accepted as incapable of explanation and the prevalence of this view is no doubt the reason why the need of an explanation is not commonly felt.

From the standpoint advanced here an explanation is demanded according to the spontaneous principles of reason, accepted, though of course not explicitly isolated, in the judgments as to the existence of oneself and other things. How then is it possible to account for the hypothesis that in throwing unbiassed dice each result is equally likely to occur? Or that the sun is as likely to radiate in one direction as another? There must *be* an explanation of the regularity manifested by large numbers of similar events, each independent of the others. Every event is determined by causes arising from the interactions of the things concerned with producing it. Such interactions are specified by the determinations of these things including the relations they bear to each other. Their determinations are the result of earlier interactions and so on backward in time. While such causes do account for each event, they cannot account for events of a similar kind tending to occur in definite frequencies, unless some additional relationship between them is postulated.

To explain hypotheses of equal chance, indeed to explain possible events tending to occur with frequencies according to definite probabilities, it is necessary to postulate an order among things such as to verify these hypotheses. That is to say, in the absence of causes of bias, the order among things must produce events verifying the chance of every possible event occurring equally. In regard to the molar laws of physics this will mean that such laws arise not only in consequence of the very nature of things but also in consequence of the accidental order amongst them. For example, the second law of thermodynamics that cool things do not heat hotter things, the laws of geometrical and physical optics are all consequent upon the order among things. Indeed, dependence upon such an order is exemplified in all phenomena arising as a resultant of many interactions in which similar phenomena are obviously incapable of being manifested on a small scale in each individual interaction. An example of the contrary type of law, exemplified on a small scale in individual interactions, and thus not dependent upon the order among things, is that of the conservation of energy, after allowing of course for the time-lag between the energy lost by the agent and the equal gained by the patient.

In passing, it is not without interest that the molar laws consequent upon the order among things are a necessary condition for human knowledge. For the rationality of Nature would not be apparent by means of sensation unless there were sensible regularity and uniformity of environment, generalised as molar laws. Moreover, such an environment is necessary for the support of life. It may also be remarked that the ultimate explanation of this order among things is the supreme governing intelligence, God. That is to say, the existence of this order should provide ground for the teleological argument from *external* finality as cogent as that from *internal* finality and perhaps more striking in that the argument is drawn from that finality which includes God's providence for man. Indeed, its full exploitation ought logically to lead to recognition by scientists of man as the centre of Nature.

It is now opportune to make an important distinction between the statistical method in classical physics and that in modern quantum physics. Consider for example heat conduction as being a result of numerous chance molecular collisions in accordance with the kinetic theory of classical physics. Although individual molecules and their collisions are subsensible and unobservable in practice, nevertheless in the abstract, in principle, the relationship between molecules by which they move to collision can be pictured and understood. In contrast the relationship between a radiator and receptor to account for interaction cannot be sensed or pictured by its similarity to what can be sensed. That a relationship must exist is a rational necessity according to reason as accepted here. Nevertheless the relationship cannot be imagined. Incidentally this is paralleled by the rational necessity of postulating that each thing is a nature and yet unquantified nature is incapable of being sensed or pictured. That radiator A will radiate to receptor B cannot be predicted in practice any more than that molecule A will collide with molecule B. But more than this, that radiator A will radiate to receptor B cannot be predicted even in the abstract, *in principle*, and this difference distinguishes individual radiations from individual molecular collisions. The circumstances causing A to radiate to B are unknown, even in principle. In consequence, according to the more usual experiential notion of reason, there is no ground for invoking causality by affirming that a radiator is caused to radiate to a particular receptor and correspondingly no necessity for explaining the applicability of statistics to Nature, as already explained. But the kind of reasoning must, in any case, be already accepted, by consideration of statistics to Nature. Hence it is untrue to assert that the unpredictability inherent in quantum physics limits the principle of causality, unless this latter principle is already admitted to be a generalisation from experience.

To give some slight indication of the character of statistical physics, consider a molecule in a given environment and suppose its actual structure at a given time could be known. If it were then introduced into another environment, probabilities could be assigned for actual possession of each of its possible structures. The actual structure possessed at any succeeding instant could not, however, be predicted, even in principle. However, the structure of the molecule at the time of introducing it into the second environment could not in fact be known. Only the probability of its possessing each possible structure could be known. *Hence, the effect of moving* a molecule from one environment to another is to change the distribution of probabilities attaching to each of the possible structures. This standpoint is not significantly different from that of quantum theory, as stated by the late Sir Arthur Eddington: 'To each type of atom is assigned a set of elementary states (eigen states), each corresponding to a different structure. It is these states, rather than the atoms themselves, that are the end-products of our analysis. The atom itself is a combination of its states; or, as we generally say, it has various probabilities of being in its different states. . . . When an atom is disturbed by other particles, its elementary states are not disturbed; their structure remains the same as when the atom is altogether isolated from its surroundings. The only thing disturbed is the distribution of probability between the various elementary states.'[2]

An important result of the unpredictability of individual events in principle is that a three-valued logic should be applicable throughout the domain of quantum physics. In the logic of non-statistical knowledge a proposition is either true or false. It is either verified in Nature or it is not verified in Nature. Before examining such a proposition rationally and experimentally, it is potentially both true and false, the completed process of examination actualising one possibility to the exclusion of the other. In the case of statistical knowledge dependent upon real relations unobservable in principle, a proposition can be true or false as before. But it can also be neither demonstrably true nor false on account of the very limitations of knowledge dependent upon what is unobservable and unknown in principle. The completed examination of such a proposition will then actualise one of the three possibilities to the exclusion of the other two. Thus, a three-valued logic is applicable to statistical knowledge dependent upon relations incapable of abstract representation, the 'Principle of the Excluded Middle' not applying to it. It is not therefore surprising that this kind of logic is applied successfully in quantum physics. That it should be supposed generally applicable is clearly inconsistent with the acceptance of Nature as an objective reality and thus inconsistent with the postulates accepted in this paper.

In this connection it is, however, important not to confuse propositions dependent upon statistical knowledge of the kind for which three-valued logic is applicable with other propositions for which the process of examination cannot be completed for one reason or another, For example, the proposition that the universe was created a finite time ago is either true or false. By observing the present state of things it might be possible to show it to be true or to be false. However, suppose from the present state of things it were only possible to compute the state of things a year ago, and so on, backward, year by year in time. By actually calculating backward, a state of things might be found such that it must have been created, thus verifying the proposition. If however no such state of things could be found, then the proposition would not have

2 Sir A. Eddington (1939), *The Philosophy of Physical Science*. Cambridge University Press. p. 127.

been shewn to be true or false by reason of the fact that the process of investigation had not been completed. At all events, it does seem unwarranted to treat of three-valued logic as supplanting a more primitive two-valued logic. Thus, the late Sir Arthur Eddington, in his book *The Philosophy of Physical Science*, writes: 'It is a primitive form of thought that things either exist or do not exist'.

To conclude, it would appear that modern statistical physics is not inconsistent with the acceptance of Nature as necessarily rational according to the principles governing spontaneous reasoning. In particular, the universality of the principle of causality implicit in spontaneous reasoning is in no sense compromised. On the other hand, if the principle of causality is regarded as a generalisation from experience, then it is a generalisation from molar experience, not from molecular experience. Thus, modern statistical physics does not greatly affect either of these diametrically opposed views as to the origin of the principle of causality. But it seems to me that the position of the majority of natural philosophers is not fixed in either of these views. Rather it has been an attempt to build a philosophy of science on the assumption that the basic problems of epistemology are irrelevant. To these natural philosophers the absence of manifest causality in individual actions appears as a disturbing influence.

A. W. GLEDHILL, B.A., Ph.D., M.R.C.V.S.

THE IDIOM OF SACRED ART

IF we seek the reason why Renaissance art touches modern man far less deeply than, for instance such creations of the XIIth century as the Christs in majesty over the great French west porches, awe-inspiring at Moissac, pentecostal in the narthex at Vézelay, apocalyptic at Chartres, will it not prove that the emotion of awe they awake in us corresponds to something transcendent in them, which we may perhaps label *numinous*? The makers were not interested in showing what they thought our Lord looked like, nor even what they would like him to look like, but only what they knew him *to be*. They lay hold on us not so much by appearances as by a two-fold reality, on the one hand concrete and aesthetic (the essence of the artefact itself) and on the other ideal and noetic (the essence of the concept it conveys). This second, ideal reality is expressed analogically by the essential perfection of the material work. Thus there is no inconsistency, as some have wrongly supposed, between Maurice Denis's famous axiom: 'se rappeler qu'un tableau—avant d'être un cheval, une femme nue ou une quelconque anecdote—est essentielle-