THE RECOGNITION OF MIRACLES

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MIRACLES HAVE attracted much attention recently on two levels. The subject of miracles is closely linked to the centenary celebration of the apparitions at Lourdes which has enjoyed widespread publicity in the press. It has also been the center of less sensational discussion in theological circles. In the preface to the centennial volume, *Lourdes 1858*, Bishop Pierre-Marie Théas of Tarbes and Lourdes writes: "The 'fact of Lourdes' is a supernatural fact with which we must not confuse the 'marvelous' upon which the popular imagination so often avidly feeds."[1] There are traces of such a preoccupation with the marvelous even in some technical theological approaches to miracles. This can be made clear by the following study of what positive science can and cannot do in the face of a supernatural fact, a miracle.

A miracle is commonly defined as an event which transcends the powers of the material universe and can be accomplished only by the direct action of the Creator Himself.[2] This definition is frequently taken as an indication of the process by which a miracle is recognized. It seems to say that we can establish merely by a study of the visible aspect of a miracle that it is a complete exception to the laws of nature. As H. H. Dubs has pointed out: "This conception belongs pre-eminently to the eighteenth century, when science promised to control the whole of life."[3] Indeed, even Hume defined miracles in the same way, though he denied their existence. In the famous passage where he discusses the resurrection of Queen Elizabeth, what he chooses to deny is the reality of the extraordinary event, not its character as an exception to the laws of nature.[4]

[1] L. -M. Cros, S.J., *Lourdes 1858: Témoins de l'événement*, re-ed. P. M. Olphe-Gallimard, S.J. (Paris, 1957) p. 5.

[2] Cf., for example, S. Tromp, S.J., *De revelatione christiana* (Rome, 1945) p. 117; J. M. Hervé, *Manuale theologiae dogmaticae* 1 (Paris, 1949) 97.

[3] H. H. Dubs, "Miracles—A Contemporary Attitude," *Hibbert Journal* 48 (1949–50) 160.

[4] D. Hume, *Essays: Moral, Political, and Literary* (London, 1912) pp. 106 f.: "But suppose, that all the historians who treat of England, should agree, that, on the first of January 1600, Queen Elizabeth died, that both before and after her death she was seen by her

Modern science, however, has assumed a more sophisticated attitude. In the opening article in an interesting controversy some years ago in the *Hibbert Journal*, Professor Dubs declares: "As long as we recognize that all scientific laws are not yet known, it remains impossible to determine positively when all scientific laws are violated."[5] Sir Arnold Lunn presents what he considers to be the Catholic answer:

> Professor Dubs is of course too intelligent to imply that science has disproved the existence of the supernatural in general, or of miracles in particular. The truth is that we believe in miracles because we believe in science. We accept the scientist as an expert within his particular field of enquiry, the natural order and the laws of nature, and it is on his authority that we declare that a particular phenomenon is inexplicable as the effect of natural agents and must therefore be ascribed to supernatural agents.[6]

The difficulty with this answer, as Patrick Nowell-Smith points out, is that it smuggles an explanation of the phenomena into the evidence for them.[7] The scientist may be trusted, as a trained observer, to give an accurate description of a real phenomenon; he may also be believed when he declares that he knows of no scientific explanation for it. "But to say that it is inexplicable as a result of natural agents is already beyond his competence as a scientist, and to say that it must be ascribed to supernatural agents is to say something that no one could possibly have the right to affirm on the evidence alone."[8]

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physicians and the whole court, as is usual with persons of her rank; that her successor was acknowledged and proclaimed by the parliament; and that, after being interred a month, she again appeared, resumed the throne, and governed England for three years: I must confess that I should be surprised at the concurrence of so many odd circumstances, but should not have the least inclination to believe so miraculous an event. I should not doubt of her pretended death, and of those other public circumstances that followed it: I should only assert it to have been pretended, and that it neither was nor possibly could be real. You would in vain object to me the difficulty, and almost impossibility of deceiving the world in an affair of such consequence; the wisdom and solid judgement of that renowned queen; with the little or no advantage which she could reap from so poor an artifice: All this might astonish me; but I would still reply, that the knavery and folly of men are such common phenomena, that I should rather believe the most extraordinary events to arise from their concurrence, than admit of so signal a violation of the laws of nature."

[5] Dubs, *loc. cit.*

[6] A. Lunn, "Miracles—The Scientific Approach," *Hibbert Journal* 48 (1949–50) 242.

[7] P. Nowell-Smith, "Miracles—The Philosophical Approach," *Hibbert Journal* 48 (1949–50) 355.

[8] *Ibid.*

To define a thing is not always to indicate the process by which it becomes known to us. This is particularly true in the case of miracles if we define them as exceptions to the laws of nature. It is nevertheless common in apologetics to maintain that a miracle is recognized by establishing that the definition is fulfilled in a particular case.

> For us to know with certainty that a given sensible event transcends the power of earthly causes, it is not necessary that we should know all the forces of nature nor that we should be able accurately and positively to delimit their absolute capacities. It is necessary and sufficient that we should know positively the course which nature should have followed in a given set of circumstances and negatively what is certainly beyond the powers of nature.[9]

This view of the recognition of miracles assumes that our knowledge of the forces of nature is sufficiently comprehensive of the essential properties of its object to tell us what nature cannot do. Now our knowledge of the forces of nature is contained in those statements describing the constant modes of behavior of corporeal reality which we call the "laws of nature." Since these laws are the direct and primary concern of the positive sciences, the scientist enters the problem of the recognition of miracles at this point. In this view, the scientist is asked the simple question: "Does this event conform to or contradict the laws of nature?" Such a question would be a foolproof criterion for establishing the occurrence of a miracle if it represented a perfect dichotomy. The positive scientist, however, will never see the question as a dichotomy, because he realizes, at least implicitly, that the phrase "laws of nature" has one meaning for his questioner and another for himself.

The two meanings are perhaps most clearly expressed in Scholastic terms. The first is based on the concept of physical natures.[10] Each material being has a nature which determines its constant mode of behavior. The sum total of these natures in the whole universe can be looked upon as the foundation of a collection of extramental "laws" actively governing the behavior of the physical universe. These laws in their entirety are the primary object of human knowledge, since our knowledge naturally desires to grasp not merely some laws, or all the laws pertaining to some determined nature, but the totality of

[9] L. Lercher, *Institutiones theologiae dogmaticae* 1 (3rd ed.; Innsbruck, 1939) 67.
[10] A. Van Hove, *La doctrine du miracle chez saint Thomas* (Paris, 1927) p. 68.

laws governing the universe.[11] Nevertheless, although the primary object of human knowledge is the *quidditas rei sensibilis*, the limitations inherent in knowledge dependent on sense perception prevent man from attaining a comprehensive knowledge of created natures.

This gives rise to a second meaning of the phrase "laws of nature." The phrase can also mean that collection of statements which men have gathered by observation in their attempt to grasp the totality of extramental laws. It is important to note that, although the first meaning is used in the definition of miracles which we have quoted, it is the second meaning which is of necessity used in a study of their recognition. This is because we can affirm that a law has been violated only to the extent that we know the law. The laws of nature in this second sense are the direct concern of the scientist. He can speak of the laws of nature in the first sense only indirectly, and only in the light of philosophy. To establish "what is certainly beyond the powers of nature" requires detailed knowledge of the laws of nature in the first sense. This knowledge, we will maintain below, is not available to man. By a consideration of the nature of scientific knowledge and of the structure of miracles we hope to show what science can and cannot do in the recognition of miracles. A study such as this can foster a sympathetic understanding of a person who recurs to "unknown natural forces" when he meets a miracle. He has refused to take off the blindfold he was forced to wear in order to play by the rules of the game of science.

THE LIMITATIONS OF SCIENCE

Scientists and philosophers agree that scientific knowledge has its limitations. To understand the extent of these limitations it will be of value to consider in broad outline the relation of science to the reality it investigates. What does science see? Knowing what it sees of reality in general, we can more easily speak of what it sees in the presence of a miracle. Do we ever come to such an intimate knowledge of the physical universe that we can definitively eliminate the natural possibility of a given event? To determine what science sees we shall examine what it does.

The collection of data is basic to any positive science, but the very

[11] G. de Broglie, S.J., *De fine ultimo humanae vitae* (Paris, 1948) pp. 128 f.

process by which data is made available is subject to a limitation which is integral to the structure of science. Data is acquired by the process of measurement, and measurement never yields a precise answer to the questions it asks. There is always some unknown variable which keeps an experiment or an observation from being a perfect copy of the one it attempts to repeat. New techniques bring an investigator progressively closer to the exact numerical value which he seeks, but they never take him all the way to his goal. A cathetometer is more accurate than a ruler for measuring the height of a box, but there is no instrument imaginable which will give the desired length with no margin of error at all. Since our most detailed knowledge of the laws of nature depends on the results of measurement, there is always a certain degree of ambiguity in that knowledge caused by the fact of experimental error.

When enough data has been collected, it is arranged in as orderly a fashion as possible. Close study may reveal general trends. These trends are expressed in general terms by the formulation of laws.[12] For example, it is a law of physics—based on patterns observed in the behavior of gases—that the volume of a gas at ordinary temperatures and pressures varies almost inversely as the pressure exerted upon the gas by the walls of the container. (The word "law" is not here used in precisely the same sense as in the phrase "laws of nature," which usually includes "laws" as described here and "theories" as described below.)

The very concept of "law" implies a second limitation of the scientific method. The exact statement of a physical law requires the language of mathematics; but the mathematical statement a scientist uses to sum up his statement is not unique, for he is free to choose one formula out of infinitely many possibilities.[13] This will be clear if we think of data as represented by points on a graph. Any curve which passes through all the pertinent data points can be considered a law. (A curve on a graph can be expressed in terms of mathematical formulas, which in turn can be considered as physical laws.) A little doodling on a sheet of scrap paper will convince the reader that there is more than one curve

[12] H. Margenau and R. B. Lindsay, *Foundations of Physics* (New York, 1957) p. 15.

[13] P. Duhem, *The Aim and Structure of Physical Theory*, tr. P. P. Wiener (Princeton, 1954) p. 171.

passing through any finite number of points on a graph. This non-unique character of physical laws is another reason why scientists hesitate to say that they know what nature cannot do. The "law" chosen to sum up the data may not have been the one which conforms to reality.

The next step in the method of science is the construction of a theory. A theory sums up in a few mathematical statements, or equations, as many as possible of the relations, or laws, pointed out by measurement. Frequently the scientist uses "models" in constructing and interpreting his theory. A model is a picture which the theorist builds up in his mind to help him predict results which can be verified by observation. Newton, for example, constructed in his imagination a model of the universe in which massive spheres attract each other with a force proportional to the inverse square of the distance between one another. That the planets are not perfect spheres has been known for some time and has been dramatically emphasized in the recent publicity given to the Sputniks and Explorers. Models are constructed by guesswork, and any model at all is acceptable if, when subjected to mathematical analysis, it predicts the observed data. All of the data available to Newton was fitted exactly by the mathematics of his theory of gravitation and by the model of the universe he used. To the extent that it fits observed data the model can be considered as analogous to the real universe. Mathematical analysis of the model gives numerical results which are the same as those we get from observation of the real universe. It is important for the purposes of this discussion to notice that a model has a merely heuristic value—that most of our real knowledge is contained in the mathematical statement of the theory, in which we express observed relations without saying anything at all about their nature.[14] This was Bertrand Russell's thought when he wrote:

> Ordinary language is totally unsuited for expressing what physics really asserts, since the words of everyday life are not sufficiently abstract. Only mathematics and mathematical logic can say as little as the physicist means to say. As soon as he translates his [mathematical] symbols into words, he inevitably says something much too concrete, and gives his readers a cheerful impression of something imaginable and intelligible, which is much more pleasant and everyday than what he is trying to convey.[15]

[14] E. B. Wilson, *An Introduction to Scientific Research* (New York, 1952) p. 30; Duhem, *op. cit.*, p. 25.

[15] B. Russell, *The Scientific Outlook* (New York, 1931) p. 82.

Recalling the distinction we have made between the two senses of "laws of nature"—extramental laws governing the behavior of corporeal reality and laws which men have constructed to describe reality by studying nature—we might say that the real universe is subject to the laws of nature in the first sense, and the Newtonian model of the universe is subject to the laws of nature in the second sense.

The Newtonian model of the universe has been superseded by more detailed models. Each new model brings us closer to complete knowledge of the real universe, but we never know how far we remain from our goal. There is an inherent ambiguity in the use of models because they are not unique, that is, any number of different models may be equally consistent with a single mathematical theory. Sir Edmund Whittaker has painted a rather graphic picture of this ambiguity:

> The vibrations of a membrane which has the shape of an ellipse can be calculated by means of a differential equation known as Mathieu's equation: but this same equation is also arrived at when we study the dynamics of a circus performer, who holds an assistant balanced on a pole while he himself stands on a spherical ball rolling on the ground. If now we imagine an observer who discovers that the future course of a certain phenomenon can be predicted by Mathieu's equation, but who is unable for some reason to perceive the system which generates the phenomenon, then evidently he would be unable to tell whether the system in question is an elliptic membrane or a variety artiste.[16]

In other words, if all we know about a phenomenon is that it obeys the relation stated in Mathieu's equation, the model which we choose to picture the phenomenon can be either a vibrating drumhead or a performing acrobat. The fact that models are not unique makes it evident that the picture of reality given us by science is not complete.

THE RELATION OF THEORY TO REALITY

The relation of theory to reality, a problem which is basically epistemological, is intimately related to our problem of the scientific investigation of miracles.[17] Can a scientific theory ever give such a comprehensive knowledge of the nature of a sensible being that it can establish definite limits to its activity? Do we know what this or that *ens mobile* cannot do?

[16] E. Whittaker, *The Beginning and End of the World* (Oxford, 1942) p. 17.

[17] Both E. L. Mascall, *Christian Theology and Natural Science* (New York, 1956) p. 89, and Duhem, *op. cit.*, p. 284, point out that an overliteral interpretation of scientific theory is the cause of many so-called conflicts between science and theology.

A digression at this point may serve to highlight the problem. Theory is intended to explain whatever is observed. When a new and unforeseen event is observed, science willingly adjusts its theories to fit the new phenomenon.[18] As Duhem has observed:

> . . . this struggle between reality and the laws of physics will go on indefinitely: to any law that physics formulates, reality will oppose sooner or later the harsh refutation of a fact, but indefatigable physics will touch up, modify, and complicate the refuted law in order to replace it with a more comprehensive law in which the exception raised by the experiment will have found its rule in turn.[19]

Quantum mechanics owes its origin to the fact that events on the atomic scale did not fit into the scheme predicted by classical physics.

The positive scientist has perforce restricted his considerations to a limited range of experience—to what is objective, communicable, and impersonal.[20] Can he, when he encounters the miraculous, do anything more than revise his theories to include the new and unforeseen phenomenon?[21] Does a scientific theory tell us what are the limits of the capacities of a given sensible being, or is theory so dependent on what is actually observed that it must be modified even when a miracle occurs? The answers to the questions we have brought up in the last two paragraphs must evidently be sought outside of science. The questions of the capabilities of material creation and of the dependence of theory on observation direct our attention to philosophical considerations.

The laws of nature as known to us are never more than an approximation to the extramental laws of nature. St. Thomas taught that we get at the natures or essences of corporeal beings only through observa-

[18] Mascall, *op. cit.*, p. 87; H. Dingle, *The Scientific Adventure* (New York, 1953) p. 295.

[19] Duhem, *op. cit.*, p. 177.

[20] G. D. Yarnold, *Christianity and Physical Science* (London, 1950) p. 92; Dingle, *op. cit.*, p. 295.

[21] E. H. Hutten, *The Language of Modern Physics* (New York, 1956) p. 215: "To take a miracle as a transgression of natural law is not of much use; we can always assume a causal sequence of which it is a member, however unique the miracle may be. We are free to invent a universal sentence, that is, a law, to fit the occasion. Tacitly, the assertion of miracles entails that there exists a definite sequence of events to which the miracle belongs, and that this sequence arises from a supernatural source. This can be said of any event, and it is therefore an empty assertion." Cf. also Mascall, *loc. cit.* (supra n. 18); E. Dhanis, S.J., "Un chaînon de la preuve du miracle," in *Problemi scelti di teologia contemporanea* (Rome, 1954) p. 63; D. Dubarle, "L'Attitude du savant chrétien en face du fait miraculeux," *Lumière et vie*, no. 33 (1957) 341; Wm. G. Pollard, *Chance and Providence* (New York, 1958) pp. 106 f.

tion of a few accidents, and that the knowledge so attained is incomplete.[22] He felt that it is the task of what we now call astronomy to "save the appearances": "In astronomy [*astrologia*] we assume a system of eccentrics and epicycles because, having done this, we can save the sensible appearances of the movements of the heavens. This system, however, is not sufficiently probative, because the appearances might possibly be saved even if we adopted different assumptions."[23] As Van Hove has remarked, this statement comes very close to modern ideas on the nature of physical theory.[24] Werner Heisenberg, for example, writes: "Mathematical formulas no longer represent nature; they represent our knowledge of nature."[25] We find the same thought in Maritain: "[The physico-mathematical sciences] in their most highly conceptualized theoretical branches reconstruct their universe by means of mathematical beings of reason founded in the real, by means of myths or symbols which as such have no connection with the real causes dealt with by the philosophers."[26]

We have seen that the scientist forms a theory in an attempt to explain the experience which he has recorded as experimental data. The "mathematical beings of reason founded in the real" which he puts into his theory have value to him only in so far as they help to explain the data—to save the appearances. A theory is accepted or rejected on the sole basis of whether it works or not. A theory works if, using it as a premise, we can deduce experimentally verifiable results from it. The consequence between theory and observed data is, for the scientist, the explanation of phenomena. Herzfeld has stated this very well:

> For the physicist "explanation" means deduction from a more general law or theory. Occasionally, a model which can be visualized is introduced at an intermediate level, besides the abstract generalization. In other words, a phenomenon or property is considered as explained then and only then, if it can be shown that it follows by pure logic (which assumes mathematics) necessarily and unambiguously from an assumed theory.[27]

[22] Van Hove, *op. cit.* (supra n. 10) p. 274; Van Hove here gives numerous references to St. Thomas.

[23] *Sum. theol.* 1, q. 32, a. 1, ad 2m. [24] Van Hove, *op. cit.*, p. 282, note 5.

[25] W. Heisenberg, *Das Naturbild der heutigen Physik* (Hamburg, 1957) p. 19; Duhem, *op. cit.* (supra n. 13) p. 20.

[26] J. Maritain, *Philosophy of Nature* (New York, 1951) p. 152.

[27] K. F. Herzfeld, "Philosophy and Experimental Physics," in *Proceedings of the American Catholic Philosophical Association* (Washington, D.C., 1952) p. 8.

MIRACLES

We leave to metaphysics the question of whether God can work miracles and we accept the obvious answer that He can. We are here concerned with man's discernment of miracles. Is it possible for man to ascertain that the laws of nature have been transcended in a given instance? This is a question whose answer requires a detailed knowledge of natural laws, and we turn for an answer to the scientist, since the study of these laws is his profession. When we ask a scientist whether a certain sensible event is naturally possible, it is evident that his answer cannot be direct. His knowledge is summed up in his theories; and the relation of theory to reality is complex, for the models of theory are no more than analogous to extramental reality. He can tell us whether his model is compatible with the physical event we describe, but he will have a lingering doubt about the value of the model. These considerations hold a fortiori for those theories which are so abstract as to have no related models. The possibility of "unknown forces" is not the *deus ex machina* it might seem to be, because only known forces can be built into a theory, and scientific theory contains our best knowledge of the forces with which God has endowed nature.

The scientific investigation of miracles would be difficult if it involved no more problems than those we have already seen, but the advent of the new physics has brought more problems, problems caused by the transition from the deterministic physical laws of the last century to the statistical laws of the present.[28] Physical laws are called deterministic if "they take for granted the perfect knowledge of a set of facts, such as the instantaneous positions and velocities of the bodies composing a system, and then state, with a precision far greater than is experimentally obtainable, these positions and velocities at any future time."[29] A deterministic theory clearly overlooks the difficulty that measurement cannot be exact. It implicitly presupposes the *determinatio ad unum* of the physical world. It seems to say that we know what physical things will do in certain ideal circumstances with complete certainty. If all theories about the behavior of physical bodies were deterministic, we might be justified in making the statement that we know with certainty the impossibility of some event. Current scien-

[28] Mascall, *op. cit.* (supra n. 17) p. 59.

[29] Margenau and Lindsay, *op. cit.* (supra n. 12) p. 189.

tific theories are not, however, deterministic; they are statistical, and there are two distinct types of statistical theory.

STATISTICAL THEORIES

The first type of statistical theory again presupposes a *determinatio ad unum* in natural bodies. It makes use of statistics in the same way that an insurance company does, for it is interested in the behavior of large numbers of individuals rather than in the behavior of one individual or the other. Statistical gas theory, for example, considers a gas in a container as an enormous number of molecules. The motion of one molecule could be studied apart from the others, at least in principle, but the theory is constructed to describe the aggregate characteristics of the whole collection, e.g., the pressure exerted by the gas on the walls of the container. It is interesting to note that St. Thomas considered the basic concepts underlying this type of theory. Question 115 of the *Summa*, for example, deals with the activity of corporeal creatures. For St. Thomas, the celestial bodies exert a causal influence on the things that happen here below in the world of inferior bodies.[30] The human will remains free, but natural bodies are not free to follow or not to follow the celestial forces. Were the ancients not, then, right in affirming that everything happens necessarily? We are interested in but one phase of St. Thomas' solution, which is taken from Aristotle:

> Some causes are ordered to the production of their effects not invariably [*ex necessitate*] but only in the majority of cases [*ut in pluribus*]. . . . Now it is clear that a cause which interferes with the activity of another cause which is ordered only in the majority of cases to the production of its effect sometimes concurs with the second cause accidentally [*per accidens*]. Hence, such concurrence, in so far as it is accidental, does not have a cause. And because of this, the result of such concurrence cannot be explained by a pre-existing cause from which it must invariably follow.[31]

This is St. Thomas' concept of a chance event.[32] Events predicted by statistical gas theory, which deals with the random concurrence of

[30] *Sum. theol.* 1, q. 115, a. 3.

[31] *Ibid.*, a. 6 c.

[32] J. De Vries, S.J., "Das Problem der Naturgesetzlichkeit bei Thomas von Aquin," *Scholastik* 20–24 (1949) 511; Van Hove, *op. cit.* (supra n. 10) 73 ff.; *Sum. theol.* 1, q. 22, a. 2, ad 1m.

known forces, are of a similar nature. Since the macroscopic effects of the random collisions of molecules in a gas are not perfectly predictable, statistical gas theory considers these collisions to be ordered to the production of the predictable macroscopic effects only "ut in pluribus." An unpredictable macroscopic effect, the result of the chance concurrence of chance collisions, is "accidental," a fluctuation without a "cause."

The difficulty which this type of statistical theory presents to the scientific investigation of miracles is rooted in the concept of fluctuations. We have said that a gas in a container is considered to be an enormous number of particles, or molecules. A fluctuation would be a departure, even for a very brief time, from the ordinary behavior of the gas under given conditions. It would be a fluctuation if, for an infinitesimal fraction of a second, the steam in a pressure cooker on a hot stove were to turn to ice without any external cause, such as a change in the temperature of the stove or of the surrounding air. A fluctuation like this is consistent with the statistical theory of gases, although it would be so rare that we could never hope to observe it. If this type of event fits within the structure of the same theory we use to explain the ordinary phenomenon of boiling water, it is difficult to say that it is an event that is contrary to the laws of nature. All we can say is that it is extremely unusual.

Fluctuations from the ordinary course of events are very improbable in any system that includes a large number of individuals. Let us say that Smalltown has a population of ten people and that New York City has a population of ten million people. Let us assume that the only laws of life and death that are operative in both communities are the ones that we ordinarily experience—there are no hurricanes or ICBM's to threaten either population. If I read in the paper one morning that half the population of Smalltown was wiped out, e.g., by an automobile accident, I would be a little surprised, but I would not find it too far out of the ordinary course of events. If I read, however, that half the population of New York was wiped out last night in automobile accidents, I would be very much surprised. What is the reason for my greater surprise in the second case? It is the mathematically demonstrable fact that fluctuations from the ordinary course of events—fluctuations of the same relative size (here, fifty per cent)—

are less probable when the system studied contains a large number of individuals. The ordinary behavior of the air in a room, its volume, temperature, and pressure, represents the most likely average effect of the random motions of the molecules present. Fluctuations from the ordinary mode of behavior are improbable to a ridiculously small degree; but they are possible. Since modern physical theories are basically statistical, no deviation is outside the scope of the theory; the laws of chance just make deviations unlikely.

The statistical nature of the highly refined mathematical statements used in today's physical theories can help one to understand the hesitation a scientist experiences when he is asked to affirm that some event is impossible to nature. The same law which adequately accounts for all the phenomena he has observed includes—with, it is true, a very low degree of probability—any number of phenomena which he has never met. He will readily admit that some happenings are extraordinary; he does not feel that this of itself forces him to look outside of nature for an explanation. It would be absurd simply to write off a miracle as a random fluctuation. We simply wish to note here once more that a scientist is not affirming a patent contradiction when he states that some other explanation besides immediate divine intervention is perhaps possible. In fact, we would not be doing violence to the structure of statistical theory if we were to say that God, in His providence, might have so "wound up" the universe at the beginning that fluctuations which He intends will occur when and where He wishes them. This would constitute a sort of mediate divine intervention, and the fluctuations would be observed by men as contrary to the ordinary course of nature. If such activity on God's part is perhaps ruled out by theological considerations, it is not ruled out by science.

Fr. Dhanis, who has been a leader in work on the theology of miracles in recent years, feels, on the other hand, that the very structure of statistical theory does render impossible the type of divine activity to which we refer. He arrives at this conclusion on the basis of some erroneous conceptions regarding statistical theories. He writes:

> We postulate a multitude of microscopic particles whose activity is subject to definite laws. What determines the occurrence, in the course of these activities, of one aggregate result [a result visible to an observer on the macroscopic level] rather than another? Such an occurrence will depend on two factors: first, the initial

state (position and velocity) of the particles in question; and second, according to quantum mechanics, the incompletely predetermined directions which certain of these particles are continuously taking. We assume that these two factors (initial state and paths recently taken) are presented to us under the aspect of disorder. This implies in particular that they do not proceed from any efficacious intention whose aim is to produce, at a given moment, one aggregate result rather than another.[33]

Prescinding from the fact that the role of quantum mechanics is not here properly expressed, we turn our attention to the role which is attributed to "disorder." It is true that, in classical statistical gas theory, we postulate that we cannot know the position and velocity of each of the myriad particles in our gas at any moment of time. This amounts to a confession of ignorance, since the measurements required to ascertain the positions and velocities of so many particles are impractical, if not impossible. It is the triumph of statistical mechanics that it is able to make valid predictions about the gas as a whole in spite of our ignorance of the motion of each molecule. It does this by assuming that the position and velocity of each particle is determined only by the rules of chance (given certain restrictions which are not to the point here). This ignorance of detail is frequently termed a "disorder." It is not valid, however, to see in such disorder the exclusion of all efficacious intention, on the part of any agent whatever, to produce at a given future time one aggregate result in preference to others. To get this much out of the disorder which is an integral part of the theory is to confuse theory with reality. As we have seen, scientific theory, which contains man's knowledge of nature, represents incomplete knowledge. The incompleteness of our knowledge has been explicitly built into statistical mechanics. God, however, does not direct the course of nature on the basis of knowledge garnered from man's theories; His knowledge is the cause of created beings. Statistical theory has nothing to say about an infinite agent who has intimate and detailed knowledge of the myriad beings which it sees only as an aggregate. It has still less to say about his intentions.

Fr. Dhanis has nevertheless imposed the disorder of statistical theory as a shackle upon God's activity.

[33] Dhanis, *art. cit.* (supra n. 21) p. 68.

[Statistical law] postulates that, on the microscopic level, the particles on which it depends are distributed without any order. Let us imagine that, on the contrary, God has intentionally created the world so that its constituent particles are so arranged from the very beginning that they will produce at a later time a miraculous exception. In all other respects the particles are in the disorder required by statistical law. In this hypothesis, because of a special intervention by God at the beginning of time, the exception to the statistical law [a physicist would prefer to call such an "exception" a "fluctuation"] will occur when it is desired. . . . As a matter of fact, if we are dealing with a statistical law, its virtual extension depends on the state of disorder of the microscopic particles considered. The state of disorder would not (in this hypothesis) be absolute.[34]

As we have pointed out above, the "disorder" postulated by statistical law is a confession of man's ignorance which is subsumed into the mathematical rules of chance used in statistical theories. There is no such thing as a disorder in God's knowledge of His creation. God could easily perform the "special intervention at the beginning of time" in a way that cannot be perceived as ordered by man. Man will know the ensemble of particles only as disordered and will be justified in speaking of it in terms of statistical theory. Perhaps an example will make this clear. Suppose we have a short strip of movie film on which is pictured the "break shot" by which a game of pool is ordinarily begun. If we run the film through a projector backwards we will see sixteen balls wander in a seemingly random manner about the top of a pool table until, with one rapid leap, fifteen of them fall into a perfect triangle and stay there. If we could devise a way to give each ball the correct start (position and velocity), we could spread balls about the top of a pool table and actually reproduce the sequence of events shown in the backward moving filmstrip, predicting exactly when the "ordered" result, the triangle, would emerge from the seeming disorder. If another person arrived after we set the balls in motion, but before the end result is achieved, and if he had no means of making accurate measurements on all the balls at once, he could make only *statistical* predictions about the future, about the probability that the final result will be a triangle, for example. This is because he can perceive no order in the system as a whole. It is therefore misleading to speak of a disorder as not being absolute, for this seems to say that statistical laws require God to

[34] *Ibid.*, p. 71.

initiate some sort of "absolute" disorder, whereas the disorder of which these laws speak is a device to take into account man's inability to perceive order. Once more we see the importance of making a sharp distinction between the "laws of nature" as known to man and the "laws of nature" to which the universe is actually subject.

Fr. Selvaggi draws a similar inexact conclusion.[35] He writes that, even though statistical considerations may apply to the behavior of a given system, there is still a certain minimum period of time required after the initial conditions have been placed before a fluctuation can take place, and that this law of minimum is a deterministic, not statistical, law. He gives as an example the case of a brick lying motionless which suddenly jumps, due to a chance fluctuation in the atmospheric pressure on one of its surfaces. He adds that we can, in principle, begin with the initial states of all the particles in the surrounding air and calculate a minimum time before which such a fluctuation is impossible.[36] This minimum is not subject to the uncertainties of statistics and thus proves that not all laws of nature are statistical. Here again we have an argument which does not take account of the true role of the initial conditions in a statistical theory. The strength of the theory is that it allows us to overlook our ignorance of the details concerning the individual particles and still to predict aggregate results with an enormously high degree of probability. We cannot know the initial conditions upon which Fr. Selvaggi would have us base our calculation, because there are too many particles involved. In practice we cannot say when a fluctuation will occur, or if it will occur; we can only say that it is so extremely improbable that we pay no heed to its possibility. Our knowledge of the laws of nature is such that fluctuations are possible; but they are improbable to a degree that overwhelms the imagination.

The second type of statistical theory in vogue today is quantum mechanics, a highly intricate mathematical formalism developed largely in the third decade of this century. Whereas the first type of statistical theory deals with the behavior of systems composed of large

[35] F. Selvaggi, S.J., "Le leggi statistiche e el miracolo," *Civiltà cattolica* 101/4 (1950) 208.

[36] Such a calculation is unthinkable only because of its complexity. Its detailed nature is familiar to any physicist.

numbers of particles, quantum mechanics deals with the behavior of individual microcosmic (molecular, atomic, and subatomic) particles.[37] It is fundamental to quantum mechanics that any statement we make about an individual particle or event must be stated in the language of probability. A quantum mechanical law can tell us only *probably* what will happen in any given case. An analogy may clarify the concepts involved. If I record the score of an expert marksman firing at a target, I have a statistical law describing many events, or shots. My law tells me accurately the pattern into which his shots will continue to fall: how many times he will hit the bull's-eye, how many times he will hit each ring, even how many times he will miss the target. The larger the number of shots I have recorded, the more accurate is my law regarding future shots; but the law does not tell me exactly where the next shot fired is going to hit the target. I can speak about a single shot only in the language of probability.[38] This is the type of statement which we are forced to make about the microcosm by reason of the nature of measurement. The fact that we have approached no closer to a complete knowledge of the physical world than to be able to state probabilities gives added strength to the objection to miracles taken from statistical theories: How can we state that something is contrary to the laws of nature if the laws of nature give us only probabilities?

There is a debate among physicists today which is not without its interest in the theology of miracles. It has to do with a problem that is basically epistemological. Phrased in its simplest terms it is: What does quantum mechanics mean?[39] Is the probable knowledge given by

[37] Although quantum mechanics applies directly only to the microcosm, it is equally valid for the macrocosm, the world of everyday experience. We do not use quantum mechanics for such problems as plotting the trajectory of a ballistic missile, simply because macrocosmic measurements are never so refined as to notice quantum effects.

[38] A problem that could be treated with considerations of this sort is the following: What is the probability that two men standing fifty yards apart, each aiming at a different target in the general direction of the other, would so aim their shots that their bullets would meet in mid-air? It takes no profound intuition to see that the probability is so small that we would consider it a practical impossibility. But bullets have met in mid-air under such circumstances, as one can verify by a visit to the Gettysburg National Museum. The extremely small probability became a practical possibility because of the enormous number of men and bullets involved.

[39] M. Bunge, "Survey of the Interpretations of Quantum Mechanics," *American Journal*

quantum mechanics the ultimate the mind can achieve in its investigation of the microcosm (and hence of the whole universe)? As Einstein once put it: "There is no doubt about the mathematical formalism of the theory, but there is much doubt about the physical interpretation of its mathematical expression. In what relation does the psi-function stand to a unique concrete event, that is, to an individual state of a single system?"[40] A theory which is deterministic and not based on probabilities would certainly be more intellectually satisfying, and there is an articulate minority of physicists who feel that it is possible to go beyond quantum mechanics to such a theory. David Bohm, for example, has published a series of articles in which he shows that a more refined and more deterministic theory may yield the same results as the ordinary quantum mechanics.[41] Einstein was a lifelong opponent of the ordinary majority view. From the year 1927 on, he repeatedly found difficulties in the common statistical interpretation, difficulties which were never answered to his satisfaction. He always felt that nature is determined outside the mind, and that a thoroughly indeterministic physics could not be the ultimate the mind could hope to attain. In 1927 Louis de Broglie gave up his initial attempts at a deterministic interpretation of quantum mechanics, but he has recently returned to the side of the determinists.

> [The indeterministic interpretation,] by seeking to describe quantum phenomena solely by means of the continuous psi-function whose statistical character is certain, logically ends in a kind of "subjectivism" akin to idealism in its philosophical meaning, and it tends to deny the existence of a physical reality independent of observation. Now a physicist instinctively remains a "realist," and he has several good reasons for this: subjective interpretations always give him a feeling of uneasiness and I believe that in the end he would be happy to be free of them.[42]

The more common opinion, however, is held by such great physicists as Niels Bohr, Werner Heisenberg, and Max Born.[43] It is that the

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of Physics 24 (1956) 272; W. Büchel, S.J., "Zur naturphilosophisch-erkenntnistheoretischen Problematik der Quantenphysik," *Scholastik* 28 (1953) 161–85. Cf. also J. R. Newman's review of D. Bohm's *Causality and Chance in Modern Physics* (New York, 1957) in *Scientific American* 198 (Jan., 1958) 51 ff.

[40] A. Einstein, "Elementare Überlegungen zur Interpretation der Grundlagen der Quanten-Mechanik," in *Scientific Papers Presented to Max Born* (New York, 1953) p. 33.

[41] *Ibid.*, p. 13.

[42] L. de Broglie, *The Revolution in Physics* (London, 1954) p. 229.

[43] W. Heisenberg, "The Development of the Interpretation of Quantum Theory,"

nature of the interaction between the observer and the thing observed (by means of a measuring instrument) rules out definitively the possibility of a deterministic theory. This opinion has many variations, and a study of these variations would have no place here. What is of interest here is that, if our knowledge of the laws of nature is by its very structure statistical, and hence partially indeterministic, there is all the more reason that statements about the laws of nature in the context of the theology of miracles must take into account the statistical nature of these laws.

It is evident that much of what has been said here has direct application only to the science of physics. What is true of physics also holds, *mutatis mutandis*, for chemistry and the biological sciences because of the close similarities in the methods of all the positive sciences. Physical statements about the microcosm are true even of the microcosmic aspects of living material beings.

This survey of the problems involved in the scientific investigation of miracles is meant to establish only one point—that science cannot see a miracle because science makes no claim to absolute certitude regarding what is impossible to nature. The recognition of the miraculous is not simply an application of the principle of sufficient reason.

THE STRUCTURE OF MIRACLES

We have thus far endeavored to point out the difficulties inherent in the scientific investigation of miracles because of the nature of scientific knowledge. We will now consider the structure of miracles to ascertain the proper role of science in their investigation. Remembering that our problem is the discernibility of miracles and not their definition, we are primarily interested in the structure of a miracle in so far as it is capable of being recognized in a concrete situation. We take it for granted that miracles are perfectly in place in the supernatural order in which we exist, and that miracles involve an exercise of the transcendent dominion of the Creator over His creation.[44]

The Vatican Council numbers miracles among those *facta divina*

in *Niels Bohr and the Development of Physics* (New York, 1955) p. 12. Cf. also the contributions of W. Pauli, M. Born, and N. Bohr to *Albert Einstein: Philosopher-Scientist* (New York, 1951).

[44] L. de Grandmaison, S.J., *Jesus Christ* 3, tr. D. Carter (New York, 1934) 17 ff.; J. A. Hardon, S.J., "The Concept of Miracle from St. Augustine to Modern Apologetics," THEOLOGICAL STUDIES 15 (1954) 241.

which are *signa divinae revelationis*.[45] Proper emphasis on the fact that miracles are both *signa* and *facta divina* can tell us much about their cognoscibility.[46] If a miracle is a sort of "word" by which God tells man of the existence of the supernatural and points out the path along which he must travel to his supernatural end, if a miracle is a sign, then we can expect science to be able to see only its visible side without being able to penetrate to its meaning.[47] If this sign-quality is an aspect of a miracle which is essential to its recognition, then we cannot ask of science that by itself it should make the final pronouncement regarding whether or not an event is truly miraculous.[48] The meaning of the sign would have to be grasped before the happening could be called a miracle.

When we turn to the recognition of a miracle as a sign we are outside the competence of science. To make this clear we can follow Fr. Mouroux in distinguishing discernibility and discernment.[49] Whereas discernibility, the capability of being recognized, is to be found only in the miracle itself, discernment is an act of knowing which involves the recognizing subject. Even the recognition of a natural sign like smoke demands acquired knowledge of the connection between smoke and fire. We can therefore say that the objectivity of the scientific method relegates it to the investigation of the discernibility of miracles. When science has testified that an event is definitely beyond the known powers of nature, it has established the presence of but one element in the totality of a miracle, but discernment requires more. A person cannot recognize a miracle solely with the help of science, because discernment involves subjective realities.[50] As a sign and a *factum divinum*

[45] Sess. 3, cap. 3 (*DB* 1790).

[46] A. Liégé, "Réflexions théologiques sur le miracle," in *Pensée scientifique et foi chrétienne* (Paris, 1953) pp. 206–18, and "Réflexions pour une apologétique du miracle," *Revue des sciences philosophiques et théologiques* 35 (1951) 249–54; F. Taymans, "Le miracle, signe du surnaturel," *Nouvelle revue théologique* 77 (1955) 244.

[47] A. Liégé, "Réflexions théologiques sur le miracle," in *Pensée scientifique et foi chrétienne* (Paris, 1953) p. 216.

[48] De Grandmaison, *op. cit.* (supra n. 44) p. 22: "We have evidently come far from the conception of miracle as an irresistible force compelling the assent of its witnesses at the expense of their free judgment."

[49] J. Mouroux, "Discernement et discernibilité du miracle," *Revue apologétique* 60 (1935) 538–62.

[50] J. Lhermitte, *Le problème des miracles* (Paris, 1956) p. 126; Dubarle, *art. cit.* (supra n. 21) pp. 338 ff.

a miracle has its visible side, and it is evidently this visible side which is seen by the scientist as a scientist.

All of Christian tradition, indeed the very etymology of the word "miracle," points to the fact that a miracle is a prodigious happening, that miracles are inexplicable in terms of man's knowledge of nature, and that they are completely contrary to what our experience has led us to expect.[51] There is no difficulty in using the methods of science to establish merely that an event is prodigious in this sense.[52] "The essential thing to which the physician should devote all his efforts is the demonstration of instantaneity or of the nonapplication of the laws of nature. . . . It is not the doctor but only the ecclesiastical judge who has the right to pronounce the word 'miracle.' "[53]

Lastly, the prodigious event must occur in a religious context. This fits well with the concept which sees the miracle as a sign, since it is hard to imagine how any wondrous event outside of a religious context could serve as a sign of the supernatural. If a blind beggar suddenly began to see in a situation which had no religious antecedents or consequents, we would not hesitate to attribute his cure to unknown natural forces.

We now have the three elements of the structure of a miracle: prodigious event, religious context, divine sign.[54] It should now be clear that it is not adequate to say that a miracle is an event that can be proven to be beyond the powers of nature and thus explicable only through the direct intervention of the Creator. This is to look only at the prodigious quality of a miracle, centering on its causal origin, and to place the whole task of the recognition of the miraculous in the hands of those disciplines whose province it is to investigate in an objective manner the laws of nature. It is perhaps better to say that the prodigious quality of a miracle is but one aspect of a knowable complex and that we ask the help of the sciences merely to establish that prodigious quality.[55] We thus include the significance of the miracle, its

[51] This statement is not equivalent to the statement that we can know an event to be a miracle because it is beyond the natural powers of the universe.

[52] Mouroux, *op. cit.*, p. 552.

[53] Van Hove, *op. cit.* (supra n. 10) p. 327.

[54] Taymans, *art. cit.* (supra n. 46) pp. 230 ff.

[55] It has been argued that it is the prodigy as religious and not merely as visible that is an exception to the laws of nature. This use of the phrase "laws of nature" is confusing,

role in the dialogue of salvation between God and man, in the actual process by which a concrete person recognizes a concrete miracle.

CONCLUSION

A miracle is a sign from God. Because it is a sign, its cognoscibility must enter into any analysis of its structure. For an event to be recognized as a miracle it is not enough that it be a true prodigy; it must take place in a religious context. Since emphasis on the transcendence of the visible aspect of a miracle can fix attention on what is only part of a whole, it might be better to put less stress on the exceptionality of miracles. We would then speak of them as events which are so inexplicable (in terms of the laws of nature as known to us) that they are the contrary of what we normally expect, events whose religious surroundings clearly show the properly disposed soul that God is communicating with him. This would eliminate needless discussions in which the theologian is drawn outside his field to treat the epistemological problems of the laws of nature.

Since we have avoided the problem of whether or not a miracle *is* an exception to the laws of nature, it would be more than our arguments could bear to suggest that the definition of miracle commonly used in apologetics be changed. It is suggested, however, that if we state in the definition of miracle that God suspends the laws of nature, then we must remember that we do not *recognize* a miracle because of its exceptionality alone. We see the miracle in the complex: inexplicable event, religious context, sign from God. It is the complex which is transcendent, which demands the intervention of God as its adequate explanation. Even if nature alone might conceivably account for the observable phenomenon, only God communicating His message can account for the complex; and only the properly disposed soul will recognize God's communication.

To say that we recognize a miracle because it is contrary to the laws of nature and that this, in virtue of the principle of sufficient reason, proves a special intervention of the Creator, is to set up a neatly logical system for handling miracles. The difficulties with this

since it seems to include considerations belonging to the moral sphere. We are more accustomed to thinking of the laws of nature as being chemical, physical, and biological—to the exclusion of the moral order. Cf. Dubarle, *art. cit.* (supra n. 21) p. 341.

system are that it does not really take into account the whole process in which miracles are actually recognized, and that it throws the great burden of proof on man's knowledge of the laws of nature. By studying the epistemology of science we have pointed out the problems involved in an unreserved assertion that man knows what nature cannot do. It is both exceptionality and religious context that bring a conviction of the miraculous to the soul that is open to the supernatural.