REALISM AND OPENNESS IN SCIENTIFIC INQUIRY

by Thomas F. Torrance

Abstract. Intrinsic to rigorous knowledge of God is the recognition that positive theological concepts and statements about God arising under the compelling claims of God's reality upon the human mind must have an open revisable structure. A similar combination of critical realism and ontological openness is apparent in the profound change that has taken place in the rational structure of rigorous science from the radical dualism and closed causal system of classical mechanics to the unifying world view and open dynamic field-theories of modern physics. It is argued that the intersection of theological and natural science in their epistemological foundations can enhance their ontological commitment and heuristic thrust.

Keywords: conceptual assent; epistemological realism/ontological openness; intrinsic intelligibility; theological/natural science; true/not certain propositions; unifying field-theory.

Let me begin with a reference to three terms from Stoic logic that were adopted early by Greek fathers in accounts of theological epistemology: *kataphatic*, *apophatic*, and *kataleptic*. While *kataphatic* was used to refer to positive statements with definite conceptual content, *apophatic* was used of negative statements with indefinite conceptual content. In the tradition of mystical theology influenced by Pseudo-Dionysius these terms came to be regarded as dialectical opposites so that *apophatic* was used to describe a purely negative or privative approach to knowledge of God in which *agnosia* or unknowing was accorded primacy. There were theologians, however, who were rather uneasy with the cultivation of a progressive ignorance in which all conceptual content in knowledge of God is finally stripped away in a complete mystical emptying of the mind. This is apparent in their employment

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[*Zygon*, vol. 23, no. 2 (June 1988).]
 ISSN 0591-2385

of *apophatic* which had been used in Greek logic for categorical or declaratory assertions made in correction of *kataphatic* statements.

Before we assess the significance of this let us turn to the third term I have mentioned, *kataleptic*. This was used to refer to the compelling claims of first principles or primary realities to which the human mind is bound to yield conceptual assent, *ennoetike sygkatathesis*, whether in immediate apprehension or in the course of scientific inquiry. If we are really to understand anything in a true and faithful way, and particularly if we are to learn anything quite new, we must let our minds fall under the compulsive self-evidence of its objective reality and its intrinsic intelligibility. Only as our minds are seized by the essential nature and truth of things in this way and we are ready to respond to them in rational, conceptual judgments can heuristic science (*heuretike episteme*) make any advance. In this event new knowledge will have the effect of calling in question or modifying all our previous knowledge, so that under the compelling claims of reality we must also engage in critical *apophatic* modes of thought in order to free our minds from false preconceptions and keep them constantly open to whatever is yet to be disclosed in the future. This applies no less to all our *kataphatic* concepts and assertions which must be kept open toward the truth they signify. They must not be allowed to close in on themselves as if they could ever contain the truth within themselves, for if they are grounded upon objective reality, their truth lies in indicating and serving that reality beyond themselves.

It may now be said that there are two rather different kinds of "apophaticism." On the one hand, *apophatic* describes a purely negative approach to knowledge of God, operating with the principle laid down by Basileides the Alexandrian gnostic, that *we cannot know what God is but only what he is not*, and proceeding by means of successive abstractions (*aphaireseis*) until a total mystical ignorance is reached. It does not take much to show that an apophaticism of this kind is inherently self-contradictory, for, as Gregory Nazianzen (329-389 A.D.) once pointed out, unless we have some positive knowledge of God we cannot say what he is not (Nanzianzen 1979-80, 24.4; 28.5, 9, 17; 30.17).[1] On the other hand, *apophatic* refers to the *epistemological reserve* we maintain in view of the fact that in all true knowledge of God we know God infinitely to transcend what we can ever conceive or say. It registers our overwhelming awe at the miracle and mystery of God's knowability. In revealing himself to us, God is not limited by our weakness or lack of capacity, but on the ground of the positive knowledge God gives of himself, we are deeply and humbly aware of the limits of what we may know of God. A powerful *apophatic corrective* is thus built into our knowledge of God, in recognition of the fact that before God all our

theological concepts and statements must have an open revisable structure.

Mutatis mutandis, we may well use the same language to speak of our natural scientific knowledge of the universe, not least in regard to the profound change that has taken place in its rational structure from the radical dualism and closed causal system of classical physics to the unifying world view and the open dynamic field-theories of modern physics. When Isaac Newton clamped down upon the phenomena of nature a framework of absolute mathematical time and space, he gave rise to a severely mechanistic description of the universe in terms of rigid cataphatic concepts and laws. That mechanistic outlook was reinforced by Immanuel Kant when he transferred absolute time and space from the Mind of God to the human mind, which meant that in natural science we do not read laws of nature out of nature but read them into nature, and thereby universalized Newtonian determinism to cover all human experience (Kant [1787] 1929, A 126-27, A 647-51, B 675-81; 1902, 37; Torrance 1984, 38-40). Moreover, when Kant correlated his "Copernican revolution" with a denial of any knowledge of things in themselves and a limitation of reason to things as they appear to us, he gave rise to a metaphysical apophaticism (of the first kind mentioned above) which had the effect of excluding God from any interaction with the world and of severing faith from reason. Here stringent cataphatic and apophatic modes of thought became the obverse of each other.

Revolution in the Rational Structure of Science

A far-reaching change in scientific understanding of the universe was initiated by James Clerk Maxwell in the third quarter of the nineteenth century when he found a conflict between "real connections in nature" and Newtonian theories based on "action at a distance" (Torrance 1984, 215-42; 1982, 1-27). The behavior of electricity, magnetism, and light simply could not be explained in mechanistic terms, which forced Maxwell to break with Newtonian mechanics and offer a very different explanation in terms of nonmechanical intelliglble relations immanent in nature, which allowed him to unify electricity, magnetism, and light in a single theory. Thus he developed the concept of the continuous dynamic field as an independent reality, which Albert Einstein called the most important change ever to have taken place in the logical structure of physical science (Einstein & Infeld 1938, 142-50).

When Maxwell published *A Dynamical Theory of the Electromagnetic Field* in 1864, Lord Kelvin wrote to tell him that in abandoning scientific explanation in terms of mechanical models he had lapsed into "mysticism"! That Kelvin should have persisted in this accusation until his

death in 1905 (the year Einstein published his epoch-making essays on special relativity and quantum theory) shows how hard it was even for the greatest scientists to appreciate the profound revolution that was taking place in human understanding of the universe. For Maxwell himself this involved a critical reassessment of abstract mathematics on the ground that it omitted an essential part of its content. He called instead for a new conception of "embodied mathematics," that is, not one abstracted from real connections in nature and then clamped down externally upon them in Newtonian fashion, but one that remained inseparably bound up with them. In this case it must be recognized that if mathematical propositions are true (that is, integrated with empirical reality), then they are logically open and thus do not have the logical certainty of propositions in an abstract necessary system.

It was with Einstein, however, that this profound revolution in our understanding of nature, and therefore in our understanding of science itself, was carried through and brought to its climax in the general theory of relativity. Here the radical dualism between absolute mathematical time and space and relative apparent time and space that lay behind the Newtonian System of the World was dismantled. Time and space were found to be inherent features of the ongoing empirical universe and inseparable from its dynamic connections and processes, and thus inseparable from one another. This gave rise to the concept of the space-time metrical field in terms of which relativity theory offered an account of the universe as a whole, but which, owing to the limited speed of light, had to be regarded as temporally and spatially finite. Expressed otherwise, by predicting their own limits the equations of general relativity point to a finite origin of the universe and also to a finite end. Moreover, since space and time embedded in the empirical structure of the universe are the carriers of all its rational order, the universe must everywhere be interpreted and explained out of its own immanent intelligibility. Instead of geometry and experience being coordinated externally with one another as in classical physics, they must be handled as inhering internally in one another, in which case geometry takes on a four-dimensional character as a "natural science" (Einstein [1921] 1954, 232-46). Hence, echoing Maxwell, Einstein argued that if mathematical propositions are true they are not certain and if they are certain they are not true. The implications of this are very far-reaching, for they imply that the universe is "finite yet unbounded" (Einstein [1921] 1954, 240-46). That is to say, the universe is essentially contingent in its nature and order and as such is amenable to explanation only in open structures of thought which point beyond themselves to an indefinite range of intelligibility in which they are grounded.

This outlook upon the created universe has been greatly strengthened by cosmological theory and nonequilibrium thermodynamics, which show that *time* has an integral place in the expansion of the universe and must be written into the fundamental equations of physical law as an internal operator, and not as an external operator as in classical physics. The universe must be regarded, therefore, as a vast temporal singularity, in fact as an immense historical event characterized by irreversibility. This has the effect of destroying the old rationalist dichotomy between "accidental truths of history" and "necessary truths of reason," and of calling in question the idea that science is finally concerned only with timeless necessary truth. It is now evident that all scientific truths and all physical laws which belong to and emerge with the expansion of the finite universe are as contingent as the universe itself. Thus, the universe increasingly manifests itself to scientific inquiry as an open intelligible system—not one in which the processes immanent within it are closed necessarily upon themselves but one which requires from us open-structured modes of thought and formulation to match its contingent, temporal, dynamic nature.

In reverting to the terms with which we began this essay we may say that the basic concepts and formalizations of our modern scientific knowledge of the universe are at once *kataleptic* and *apophatic*. They are *kataleptic* for they represent what we are bound to say about the nature of things in the universe under the compelling claims of reality. They are not cataphatic laws which we lay down in Newtonian or Kantian fashion but are laws imposed upon us cataleptically by the inherent intelligibility of the universe. However, since this intelligibility is contingent, by its very nature it directs us far beyond itself to a transcendent ground of intelligibility as its sufficient reason. While it is due to that ultimate ground of intelligibility that we think in science as we are obliged to think, it is also owing to the reference of our scientific concepts and formalizations to that ultimate ground that they break off and point mutely beyond their own limits. That is to say, scientific concepts and formalizations are *apophatic*, but apophatic in the second sense, for it is on the actual ground of knowledge gained as we are seized from beyond ourselves by the intelligibility of the universe that we are made aware of their inherent limits.

Open-structured Thought-forms in Science

Let us now consider several crucial issues in scientific knowledge where this *apophatic* characteristic appears.

Scientific concepts and formalizations comprise both definable and indefinable elements. This was pointed out by Blaise Pascal when he showed

that in mathematical proofs, no matter how rigorous, it is impossible to operate only with explicitly defined terms, for in any definition one set of terms is defined only with reference to others which within the definition must be left undefined. Thus, in any formally defined knowledge we rely upon informal knowledge of something else which means that we cannot use formal statements alone separated from the informal assumptions that regulate their function. This apophatic openness of explicit, specifiable knowledge to implicit unspecifiable truth is nowhere more evident than in the basic concept of *order* which cannot be given any formal definition, for in all such operations we must presuppose order. Order is an ultimate belief, a controlling assumption on which we rely in all scientific activity in discovery and verification alike. It is under the imperative of an ultimate ground of order of which we are implicitly aware at the back of our mind that all our rational and orderly activity is undertaken. This is what lies behind the scientific instinct or conscience, an intuitive contact with the commanding intelligibility of the universe which we cannot rationally resist. In our moral conscience (*syneidesis*, *conscientia*) we share with others, on the same horizontal level as it were with ourselves, an explicit awareness of what is right and wrong, but we also share with them an implicit awareness that comes to us, vertically as it were, from God and exercises a regulative role in the formation of our common moral judgments. It is evidently in a similar way that our scientific conscience operates in the intersection of specifiable and unspecifiable factors. Scientists share with others in the worldwide community of science accepted standards of truth and falsity consistent with the body of universally established knowledge, but they also share with others direct intuitive contact with the intelligible nature of reality which they acknowledge as the ultimate judge in all questions of truth and falsity. It was his recognition of the primacy of the latter over the former that lay behind Einstein's many striking statements about the nature and behavior of "God" (cf. Torrance 1976, 302-307). In these he appealed to and betted stubbornly on his scientific instinct in respect of some idea or theory even in face of a powerful array of evidence and arguments adduced by others against it. That is to say, in the last resort the explicit conceptual content of scientific theories and formalizations relies on and is controlled through apophatic meta-relation to implicit conceptual recognition of objective truth.

This is a basic aspect of all rigorous scientific knowledge which has been highlighted and subjected to careful examination by Michael Polanyi, who speaks of it as *the tacit dimension*. In book after book devoted to the epistemology and methodology of scientific inquiry Polanyi has shown not only that the basic premises with which science

operates are a set of ultimate beliefs which cannot be put directly to an experimental test, but that all its explicit statements can impact reality only by virtue of a tacit coefficient (Polanyi [1946] 1964; 1967; 1969; cf. Torrance 1980). Even in mathematics human reason relies on an ultimate knowledge, the content of which cannot be fully explicited. Hence, Polanyi exposed the damaging effects of a rationalism that seeks to reduce all knowledge to explicit concepts and statements by demonstrating that a wholly explicit knowledge is unthinkable and impossible. Moreover, he pointed to the presence of an "unaccountable element" in science that underlies and empowers both discovery and verification, for it enables us to integrate clues beyond our direct control and even to anticipate the manifestation of hitherto unknown aspects of reality (Polanyi [1962] 1969, 105-20; 1972, 11-25). In illustration of this we may point to the way in which Maxwell produced his elegant equations for the electromagnetic field which, as Einstein once said, led to a heuristic principle far beyond the range of the applicability or even the validity of the equations themselves.

A stress upon intuitive apprehension and an awareness of the limited range of human understanding and explanation were particularly prominent in all Einstein's own accounts of science. He was dominated by a feeling for the mysterious intelligibility manifest in the universe and reflected on "the humble attitude of mind toward the grandeur of reason incarnate in existence, and which, in its profoundest depths, is inaccessible to man" (Einstein [1948] 1954, 49). This is what he used to refer to as the religious spirit of science. "The scientist's religious feeling," he claimed, "takes the form of a rapturous amazement at the harmony of natural law, which reveals an intelligence of such superiority that, compared with it, all the systematic thinking and acting of human being is an utterly insignificant reflection (Einstein [1948] 1954, 40). On the one hand, Einstein could insist on the most rigorous deductive and cataphatic activity in scientific inquiry and formalization in achieving as far as possible a complete logically uniform system of concepts and laws which might constitute the ultimate basis from which to carry through a radical simplification of all we may know about the universe (Einstein [1936] 1954, 290-325; [1940] 1954, 323-55; 1935, 139-41, 180-81). On the other hand, however, he insisted that the fundamental concepts and ideas with which physics operates are not themselves derived through logical deduction but only through sympathetic penetration into the profound intelligibility of the universe. In the last analysis it is with reference to these basic intuitively reached concepts that any scientific theory or system is to be justified (Einstein 1929, 126-32). What makes all this possible, Einstein claimed, is the astonishing fact that there is somehow a "preestablished harmony" between the human

mind and the rationality embedded in the universe. Einstein was echoing not only Gottfried Wilhelm Leibniz, from whom he took the expression of a "preestablished harmony," but Maxwell who pointed to the mysterious connection between the laws of nature and the laws of the human mind so evident in the bearing of mathematics to non-mathematical physical realities.

It was this all-important ontological connection between the rational operations of science and the profound intelligibility manifest throughout the universe that evidently fostered Einstein's passionate search for a unified field theory. The ultimate objective of such a field theory, he claimed, is "not only to know how nature is what it is, but why nature is what it is and not something else" (Einstein 1929, 126). Thus, Einstein felt that science has arrived at the all-significant stage where it must do more than discover the laws of how things actually are: "Promethean" though it may appear, it must try to penetrate into the unifying center of those laws and discover the inner reasons for them. That was for Einstein himself "the religious basis of the scientific enterprise" (Einstein 1929, 126-27). That is to say, Einstein declined simply to suspend judgment, to rein back the forward leap of his mind in a kind of *epoché* at the way things actually are; instead he projected his thought onto religious ground, for it is there he instinctively felt that the ultimate center unifying all scientific laws is to be found. At that point cataleptic compulsion and apophatic humility become linked together.

An apophatic openness is found at the frontiers of knowledge reached by scientific research in microphysics and in astrophysics, that is, at so-called *zero points* where physical laws become critical and our scientific concepts are cut short. I think here particularly of the probing ideas put forward by John Archibald Wheeler in relation to quantum theory where, he claims, we touch the very edge of created being and where questions as to the ultimate ground of existence are forced upon science. It had long been argued that ultimate questions of this kind must be left to metaphysics and theology, but Wheeler is not satisfied with that, for here at zero points on the frontiers of knowledge where everything appears disorderly and lawless, he insists that there must be some "regulating principles," some "law without law," to give meaning to physics (Wheeler 1983, 182-213). That is to say, if scientific research into the rational structures of nature that are found to apply equally to the behavior of subatomic particles and astronomical objects in the expanding universe is not to run out into pointless inanity, it must be locked into a law-giving, order-creating ground beyond what we can detect and verify in any experimental way. It will not suffice at this juncture to fall back for an "explanation" onto statistical accounts of a

regularity based on chaos, for no law springs unguided out of absolute chaos. Must we not find a way, Wheeler asks, of penetrating beyond particles, beyond fields of force, beyond geometry, beyond space and time themselves, into the untouchable, indivisible acts of creation? That is the crucial question that arises at the baffling apophatic impasse to which our science has now carried us, but where the cataleptic force of the mysterious intelligibility embodied in created reality will not allow us to fall back into the irrational darkness of sheer negativity.

Theological and Scientific Inquiry

What are Christian theologians to make of the impasse of scientific activity at these boundary points where being borders on nonbeing, order borders on disorder, and where the intelligibility of the universe appears to run out on our inquiries? Undoubtedly we must have recourse to the biblical doctrine of creation understood in the light of the Incarnation, according to which the universe of things visible and invisible has been freely created in being and form out of nothing by the Word of God, and is unceasingly sustained in being and form by the free creative presence of that Word. That is to say, in being brought into being the universe has been given a creaturely reality of its own completely different from but dependent on the uncreated Reality of God, and it has been endowed with a creaturely rationality completely different from but in created correspondence with the uncreated Rationality of God. In technical terms, the universe is essentially contingent in its nature and in its order. Through its correlation with the unlimited freedom of God who is the creative Source of all rationality, the contingent order of the created universe is characterized by a subtle freedom and a refined intelligibility that cannot be construed merely in terms of chance and necessity, or statistical probabilities, but must be understood finally out of its inner relation to the creative and ordering force of the Word of God.

Since it is from the Word of God that the whole creation derives the intelligibility that makes it accessible to human knowledge, and since it is from the same Word of God that human beings derive the created light of reason which enables them to tune into the intelligibility of the universe and bring it to rational expression, it is ultimately to that Word that we must surely turn at the apophatic junctures of scientific inquiry where we look for a regulating principle to give order to what appears to crumble down into disorder as the established laws of nature become critical. This is to say, we must approach the baffling problems of science at the frontiers of knowledge by approaching them from the other side, from the Word of God that lies behind all the intelligibility and order of the created universe. It will be through correlating our

scientific investigations at the very edge of being with the creative origin of being, that we may grasp something of the law beyond law, the transcendent order that gives meaning to our science.

In this event it will be up to scientists, no doubt in conjoint inquiry with theologians, to acquire the habit of listening for the Word of God that lies behind the intelligibility pervading the universe, for the transcendent Word of God is, so to speak, the "cosmological Constant" by reference to which beyond themselves all creaturely events within the space-time universe are maintained in order, but apart from which they have no unifying center. This would seem to imply that the scientist should cultivate an *auditive mode* of intuitive knowledge, if he is to penetrate into the inner reasons of nature's laws and grasp something of the regulating principle behind their order. Scientists are not unfamiliar with this sort of approach for it is only through coordinating word language with symbolic language that they can engage in mathematics, and it is only as they correlate number and word that they can decipher the mathematical patterns of light signals and make use of the information they carry to discover and interpret the secrets of nature.

This epistemic correlation between number and word would appear to have a deeper basis in the astonishing connection between the laws of the human mind and the laws of nature. This is very evident in the relation between mathematics and physics in virtue of which the mathematical physicist is sometimes able to discern a hidden pattern by "tuning" into the intrinsic intelligibility of nature in anticipation of any disclosure through experimental data. That was the intuitive way in which Einstein operated in reaching relativity theory. When Jacques Hadamard, a French mathematician, once asked him about what kind of "internal words" mathematicians made use of, Einstein said that in his own case words or signs of this kind came at a secondary stage, but when they intervened they were "purely auditive" (Einstein [1945] 1954, 25-26).[3] A striking example of this may be taken from a letter of Einstein to Max Born in 1926: "Quantum mechanics is certainly imposing. But an inner voice tells me that it is not yet the real thing. The theory says a lot, but does not really bring us any closer to the secret of the 'Old One.' I, at any rate, am convinced that *He* is not playing at dice" (Born 1971, 91).

If scientists, then, already operate with an inner relation between number and word, what the theologian asks of them is to give more weight to *word* in the service of number so that at the frontiers of their numerate knowledge they may be open to the unifying center of meaning and order in the transcendent and creative Word of God. Openness to the Word of God in this way would represent a "mystical" expansion and deepening of their appreciation and grasp of the mar-

velous intelligibility of the universe more commensurate with its unbounded range. A mystical openness in marginal control of scientific inquiry would not diminish but enhance its heuristic thrust, for openness to the cataleptic claims of objective reality is the epistemic correlate of realism.

NOTES

1. Gregory's arguments are set out in contrast to the stark negativity of Eunomius.
2. See my account of Maxwell's revolution in axiomatic substructure of physics (Torrance 1984, chap. 6; Maxwell 1982, Introduction).
3. Yet see also Einstein's claim that his thinking went on "for the most part without signs (words)" (Einstein 1951, 9).

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