GOD AND THE CONTINGENT WORLD

by T. F. Torrance

The basic problem that faces us in the relations between theological science and natural science has to do with a paradox in the heart of natural science itself. The understanding of the contingent nature of the cosmos, upon which all empirico-theoretical inquiry rests, derives not from natural science but from Judeo-Christian theology, that is, from the doctrine of God as Creator of the orderly universe, who brought it into existence out of nothing and who continuously preserves it from lapsing back into chaos and nothingness. Nevertheless scientific investigation of this created order, in accordance with its distinctive nature, must be pursued without reference to God or recourse to theological reasoning.

Natural science assumes the contingence as well as the orderliness of the universe. If there were no order in the universe it would not be accessible to scientific knowledge; if the universe were not characterized by contingence, the laws of nature would be derived from it immediately and necessarily through logico-deductive processes without experimental questioning of nature, which would make empirical science quite pointless.

Let it be granted from the standpoint of natural science that the conception of creation out of nothing is incomprehensible because when we think about the creation of the universe by God we pass beyond the possibilities of our intramundane knowledge. It is much the same difficulty we have with the derivative notion of contingence. Our scientific thought moves within the space-time domain of our empirical world and is confined within its immanent possibilities. Within this framework, contingence, if it is not inconceivable, at least cannot adequately be conceptually represented and thus confronts us rather like a surd as something which is finally intractable to scientific formalization. In the pursuit of our scientific inquiries we can only move along the intelligible relations and their sequences latent in the world until we reach the boundaries where they break off. Our

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theories come up against the limits set for us by the initial conditions of nature which, though they cannot be accounted for within the frame of our physical laws, are nevertheless essential to the scientific enterprise. We push back our explanations to the ultimate assumptions on which they rest, and there becomes starkly disclosed to us the sheer contingence of the cosmos. Now we are forced to treat contingence not merely as a presupposition but as a fundamental factor in the basic structure of our scientific theories and explanations of order in the universe.

However, such an integration of contingence and order in the universe cries out for an originating reason for this state of affairs and opens a door onto the ultimate intelligible ground on which the universe itself and our knowledge of it rest. Thus contingence and order which our science presupposes and which it cannot account for within its own conceptual systems carry our thought back to God the Creator. In view of this we must take a closer look at the idea of contingence as it derives from Christian theology and examine in some detail the reactions of natural science to it.

The Idea of Contingence

It may be helpful first to recall that the idea of contingence—as chance event or accident—was not altogether lacking in Greek thought, but there it was regarded as the polar antithesis to what is rational, the logically and causally necessary. Since the rational and the necessary were identified, the contingent could only be a synonym for what is irrational or unintelligible. Behind this lay two far-reaching presuppositions: (1) A necessary and timeless relation between God and the world—this implied that the world was not created by God but was conditioned by him and made the embodiment of divine reasons, the eternal forms which are the ground of its intelligibility. The effect of this was to make it virtually impossible to distinguish nature from God. (2) A radical dualism between the intelligible and the sensible, or form and matter—while the actual world was regarded as composed of form and matter, form was held to be the definable, timeless, rational essence of things which makes them what they really are, but matter was held to be only accidentally related to the intelligible and necessary, as appearance to reality or shadow to truth. This had the effect of restricting scientific knowledge to the realm of intelligible forms and changeless essences and of reducing contingence simply to what is deficient in existence and lacking in rationality. By identifying rationality and necessity Greek science could think contingence only up to a point, by thinking the element of

necessity behind it. But this is to think contingence away and indeed to deny it any possible place within rational cognitive activity. This accounts for the lack of the all-important empirical factor in ancient natural science, for the contingent and the empirical belong inseparably together.

Looking back I think it seems clear that a proper notion of contingence could not arise so long as there remained intact the determining presuppositions of Greek science, a necessary relation between God and the world, and the bifurcation between form and matter. A basic change in the attitude to nature and to science would have to take place, involving belief in the full reality of matter and the rationality of the contingent. But that required a profound change in the conception of God and his relation to the world, in fact a radical doctrine of creation in which matter and form were regarded as equally created out of nothing and as inseparably unified in one pervasive, contingent rational order in the universe. A divine creation of matter out of nothing would require it to be treated as contingent reality and not as unreal; and a divine creation of form out of nothing would require it to be differentiated from God's eternal and uncreated rationality as contingent rationality. That is precisely the revolution that Judeo-Christian theology injected into the foundations of Greek thought while at the same time taking up its mathematical approach to the interpretation of nature as endowed by creation with a contingent rational order.[1]

The doctrine of the creation of the world out of nothing had its roots in the Judaic understanding of the one God, who is the Source of all that is outwith Himself and who remains transcendent Lord over all that He has made, so that if He were to withdraw His creative and upholding presence from the creation it would lapse back into chaos and nonbeing. This teaching carried with it both a conception of the free relation of God to the world, by which its contingent nature is constituted, and a unitary outlook upon the world creatively regulated by God's Word, which called in question all forms of religious, cosmological, and epistemological dualism. The creative act which brought the universe into being and form was not regarded as limited to its initial impulse but as remaining unceasingly operative, preserving, unifying, and ruling over all created existence, which conversely was contingent in every respect of its nature and in no sense divine.

However, it was Christian theology which radicalized and deepened the notion of contingence and gave reality to the notion of contingent intelligibility through thinking out the relation of the creation to the incarnation of God's Word in Jesus Christ within the spatio-temporal

world. On the one hand clear differentiation between the incarnation as the personal embodiment of God's Logos in a particular creaturely being and the creation of the world out of nothing as an orderly cosmos shattered the Greek idea that the intelligible order of the world is to be understood as a general embodiment of the divine Logos immanently within it, that is, as its necessary, inner cosmological principle. That was to have very fruitful effects in liberating the world from its inward bondage to divine changelessness and necessity. On the other hand the interrelation between the incarnation of the Logos and the creation of all things visible and invisible out of nothing by that same Logos called for a profound rethinking of the relation between God and the world as one in which it is recognized that the radical distinction between uncreated and created being, between the uncreated rationality of God and the created rationality of the world, far from reducing the being and rationality of the contingent world to unreality and insignificance establishes their reality and secures their significance.

This constitutive relation between God and the world is neither necessary nor arbitrary but is both free and rational. The world needs God to be what it is, but God does not need the world to be what He is, the eternally self-existent God who is not dependent on anything other than Himself. There is thus an asymmetrical relation between God and the world, characterized by perfect freedom on God's part and sheer dependence on the world's part. Since the Creator was free not to create, His act of creation is to be understood as an act of pure liberality and grace, that is, a contingent act unconditioned by any necessity in God. It is because the created world is not necessary for God's being but is freely given by Him a reality of its own distinct from His that it is contingent, independent of any necessity in God, but dependent upon the act of His beneficent will.

This relation between God and the world is also irreversible in the sense that while the world is upheld continuously in its being and form by the creative presence of God there is no logical chain between them and therefore no logical reversibility. To hold that there is such a relation would mean lapsing back into the Greek view that the rational forms of the deity are embedded immanently and materially in the universe; this, as we saw, would eliminate the conditions necessary for the emergence of empirical science.

To reject that view is not to hold that the relation between God and the world is arbitrary or irrational. It is to operate with a relation between the creative rationality of God and the created rationality of the world. Far from isolating the world from God, the contingent relation between them means that the world even in its creaturely

otherness from God is held continuously in such an ontological relation to Him, the Source of all rational order, that there is imparted creatively to the world a rationality of its own which is not incongruous with God's rationality. What we find difficult to understand is that God who has no need of the world should have reason to create such a rational world; yet it is that reason hidden deep in God that ultimately lies behind all the reasonableness of the created order. Insofar as that reason is disclosed in the incarnation, it is to be equated with the sheer mystery of God's love, which knows no reason beyond its own ultimateness as the Love that God is. That is to say, the reason for the creation is theologically to be traced back to the free, ungrudging will of God's love to create a reality other than Himself which He correlates so closely with Himself that it is made to reflect and shadow forth on its contingent level His own inner rationality and order.

The conceptions of contingence and contingent intelligibility that derive from Christian theology are not easy to represent in precise conceptual terms because of the asymmetrical and irreversible relation between God and the world. What makes contingence so baffling is the peculiar interlocking of dependence and independence that it involves. The independence of the world depends entirely upon the free creative act of God to give it being and form wholly differentiated from Himself, but that is then an independence that is delimited by the dependence that anchors the world beyond itself in the freedom of the Creator. More concretely this means that in creating the world God gave it a natural condition and status of its own in such a way that in order to do it justice we are obliged to concentrate on it for its own sake. Thus while on the one hand we cannot investigate the contingent world scientifically out of its own contingent processes without, as it were, a methodological turning away from knowledge of God, on the other hand we cannot adequately apprehend the radical nature of contingence except from the perspective of the Creator and His free act of creation.

There is no intrinsic reason in the universe why it should exist at all, or why it should be what it actually is. Hence we deceive ourselves if in our natural science we think we can establish that the universe can only be what it is. The universe is not some sort of *perpetuum mobile*, wholly consistent and complete in itself and thus imprisoned within a pointless circularity of inescapable necessities. On the contrary the universe constitutes an essentially open system with an ontological and intelligible reference beyond its own limits which cuts the circuit of any possible closure of its internal processes reentrantly upon themselves and thereby gives them their distinctive open-ordered intelligibility. Thus it belongs to the very nature of the universe that the

consistency of its own independent status and condition is incomplete and requires to be completed beyond itself. That is another way of saying that the independence of the universe is both grounded in and limited by its radical dependence. Given that dependence or openness, or reference of the universe beyond itself, which is part of what contingence means, contingence also represents the fact—so important for natural science—that the universe is endowed with an autonomous character both as a whole and throughout its immanent relations, with features and patterns and operational principles which belong to it as by intrinsic natural right and which require an autonomous mode of investigation appropriate to them.

There is a cognate aspect of contingence and intelligibility that we must note—the fact that as freely created by God the universe exhibits a contingent freedom of its own, grounded on the transcendent freedom of God, but since it is grounded in that freedom it also is limited by it and thereby established as contingent freedom. This correlation of the freedom of the universe with the unlimited freedom of God enters into the very core of contingent intelligibility and the kind of spontaneous order that it yields in nature.

Let us look at this from a slightly different angle. Since there is no reason in the universe why it had to be this particular universe, for it might have been otherwise, its actualization as this universe of ours must be thought of as one of numberless possibilities. Thus from a purely theoretical approach, in which we are concerned only with conceivable possibilities, we are unable to decide which possibility is the right and true one, that is, which is intrinsic to the actual reality of our world. There is only one way of discovering that—by testing them for empirical appropriateness. For example, in determining some physical law we may be able to produce several different formulations of it, all of which are theoretically equally acceptable, but the one alternative we finally choose to the exclusion of all others we choose under the compulsion of empirical evidence, for it is finally nature itself alone that can disclose to us its hidden patterns and thus be the judge of the truth or falsity of the many possible theories we bring to it. What lies behind this remarkable openness of nature to a variety of possible interpretations is the contingence of the universe upon the unlimited rationality and freedom of the Creator. If this contingence makes the universe mysterious and baffling, it is not because it is deficient in rationality but rather because the extent and nature of its rationality exceed our capacity to achieve complete mastery over it and so to reach any final formalization of it. It is through being correlated to the endless possibilities of the Creator that the universe is endowed with innate power constantly to surprise us in its manifes-

tation of unexpected features and structures which nevertheless always turn out to be consistent with its other features and structures.

Science's Reaction to Christian Contingence

When we turn to ask how modern science since Galileo Galilei and Isaac Newton has reacted to this Christian conception of contingence, we find it exhibiting a rather ambivalent attitude toward it. That is understandable in view of the two-fronted character of contingence, away from God and toward God. Certainly the fundamental place of contingency in the presuppositions and in the day-to-day pursuit of modern science is unquestionable. This is particularly apparent in its reliance upon experimental evidence as utterly essential and not in any sense optional and in the interdependence of experiment and theory grounded upon a rationality inherent in nature. But it is no less evident in the development of autonomous modes of scientific inquiry appropriate to the contingent, autonomous nature of the world. This involved what might be called a "methodological secularism," that is, an orientation in which science bracketed the world off from its relation to God in order to investigate its nature for its own sake. Before long, however, methodological secularism overreached itself and gave way to dogmatic secularism. Thus there was brought about the climate of thought in which many modern people have found it rather difficult to accept contingence in any radical form, for as soon as the dependence of the universe upon the Creator is pushed aside the independence of the world tends to arrogate to itself the status of a wholly self-supporting and self-explaining necessary system. In the course of such a development an overrationalizing of autonomous scientific method easily pushes empirical science into empiricism in which it tumbles back into rationalism.

In natural science this problematic attitude to contingence may be traced back to its Newtonian foundations. For Newton himself science was concerned with contingent relations and states of affairs in the actual universe of bodies in motion and was dedicated to establishing a rigorous knowledge of this universe through experimental questioning of nature and consistent, critical handling of empirical evidence. He invented the conceptual instrument of "fluxions" to help him penetrate and describe the differential structure of the universe and offered a systematic interpretation of it with the aid of a radical distinction between absolute mathematical time and space and relative apparent time and space. Thereby, however, he recast the knowledge he gained within the framework of an antecedently conceived system, an axiomatic Euclidean geometry concerned with the relations be-

tween rigid bodies independent of time. Hence what emerged in the developed thought of the Newtonians was a hard mechanistic system, a rigid determinism of physical law, which undermined the contingent foundations of natural science. This is not to say that the pursuit of experimental science slackened, but it was often regarded as a preliminary stage on the way to the establishment of necessary causal relations which could be achieved only by way of abstracting from contingent states of affairs. Here we have evidence of a tendency in the scientific mind within a dualist disjunction between the theoretical and the empirical to overstress the theoretical to the detriment of the empirical ingredient in knowledge. The formal element in our observations is isolated and erected into a nomistic structure and then imposed prescriptively upon nature.

That tendency was even stronger in the empiricist science of Ernst Mach and the theoretical physicists who with him fell under the influence of Immanuel Kant, according to whom laws of nature are not read out of nature but read into nature. The "contingent" or "accidental" (*zufällig*), Kant argued, does not exclude necessity but implies it, for the contingent refers to that which is necessary under a condition.[2] Since the contingent exists only in a series of causal connections between contingent events reaching back to what is unconditionally necessary, contingence is only a manifestation, at two or more removes, of necessity. This really represents a lapse back into the Greek conception of contingence as having a built-in relation to necessity. In this context that would mean that contingence in the universe is found only under condition of a necessary relation to physical law. But actually the reverse seems to be the case: Physical law obtains only under conditions of contingency in the universe; otherwise physical laws would have to be cut off from the contingent basis upon which natural science rests.

The ambivalent attitude to contingence and the difficulty of breaking free from the contingence-necessity syndrome are very evident in problems raised by quantum theory. I have in mind particularly the cognate notions of indeterminacy and uncertainty made so prominent in the Göttingen form of quantum theory and the questions they roused. Is the unpredictability in the behavior of quanta the result only of our inability as yet to get at causal connections irrespective of ourselves as observers and the distorting interference of our measuring instruments, or is it inherent in reality and therefore to be accepted as a fundamental feature of nature to be taken into account in all physical law? Is nature characterized by chance elements that bear no relation to necessity, or is chance at the atomic level to be

rationalized through reference to a deeper necessity at the subatomic level?

This ambivalence is reflected enlighteningly in the friendly clash of opinion between Albert Einstein and Max Born. Einstein's rejection of chance was interpreted by Born as a lapse into determinism, but, as Wolfgang Pauli rightly showed him, Einstein was not a "determinist" but a "realist."[3] Natural science, as Einstein understood it, is dedicated to the apprehension and description of realities themselves and not merely of the probability of their occurrence, far less of our observations of their occurrence. And since all knowledge of reality starts with experience and ends in experience, science must operate with basic concepts and principles that are empirically grounded and which, when they are made the basis for deductive reasoning, must not be abstracted from their empirical content. The recognition of that fact, Einstein claimed, really came home to him only with the general theory of relativity, which took into account a wider range of empirical facts in a more satisfactory and complete way than was possible on a Newtonian basis. Hence in quantum theory Einstein called for much the same kind of continuous, dynamic relatedness inherent in reality as had forced itself on him in relativity theory, but that meant operating with a very different conception of rational order for which the chance/necessity dialectic was irrelevant.

Einstein's views apart, what relation does indeterminacy bear to contingence? Certainly the notion of indeterminacy seems to be conceivable only with reference to a system characterized by determinacy. That would imply that indeterminacy and determinacy are the obverse of one another, each delimiting and negatively defining the other on the same logical level. Is indeterminacy then only an approximation to determinacy, that is, contingence in the Kantian sense of what is held under conditions of causality and necessity? For Werner Heisenberg something more than that was intended: a real feature in nature which is not explicable within the terms of a causalist and necessitarian system because it falls outwith the states of affairs to which causal and necessary laws apply. Does indeterminacy then refer to something quite random and arbitrary and therefore unintelligible? If it does, the very foundations of science are put in question, so that it would be natural for scientists to react in favor of the view that contingency arises in their minds only when they are unable as yet to reduce everything in the universe to causal laws. This would imply that they believe that the notion of contingence would disappear progressively the more progress they made along those lines; however, this would cut away the empirical foundations of natural science. On the other hand, if indeterminacy does not refer to something

quite random and arbitrary, does it not refer to an intelligible contingent relation requiring for its elucidation a different set of operational principles? In this event indeterminacy must be regarded as implying that the operational principles of classical mechanics, formalized as physical laws, have only a limited range and validity but that they may be related to the required new set of operational principles much as the principle of noncontradiction in logic is related to the wider and richer principle of sufficient reason. That is to say, physical laws must be formulated under conditions of contingency, where contingence is held not just as an essential presupposition but as a constitutive factor in the structure of natural law.

Two questions demand further consideration. The first concerns initial conditions. Classical physics already had recognized these as inexplicably given factors, contingent for they might well have been different and yet unique for once they are given they cannot be undone. Laws were formulated under conditions of these contingent factors, but they were treated only as presuppositions that could not be included in the explanatory structure of physical laws. However, in a finite and expanding universe in which time enters as an essential ingredient into its empirical reality, the questions why there are initial conditions rather than not and why the initial conditions are what they are cannot be avoided. That is to say, the initial conditions are also boundary conditions that bear upon an intelligible ground beyond themselves and that require this metaempirical reference to be integrated consistently and intelligibly with the universe. In virtue of that consistency and intelligibility should not initial, contingent conditions be treated as fundamental factors in our physical laws, which might help us understand, up to a point at least, why they take the form they do?

The second question concerns accidental features. If we are concerned with an intelligible relation in nature to which the dialectic of chance/necessity, indeterminacy/determinacy is not properly applicable, then the concept of the "accidental" needs to be rethought on an objective ground of its own. I have in mind here a remark of Heisenberg with reference to the kind of accident which plays so important a role in Darwinian theory, that accident may be "something very much subtler than we think."[4] The problem of accident or chance in Darwinian theory, to which Heisenberg himself did not allude, is that it is tied into a mechanical or deterministic explanation of natural selection, which means that its apparent stress on sheer contingence is not what it seems. The appeal which we are tempted frequently to make in various fields to an infinite number of chance events or accidental variations to account for the emergence of a new phenomenon in

nature is often little more than the imposition of a "black box" on the really significant connections (which is a way of not thinking of their internal order) and seems inevitably to lead to a determinist result. It would appear that in the long run resort to so-called probability laws and chance laws in a merely statistical resolution of the problem of indeterminacy or uncertainty would have a similar result and so fail to uncover any objective dynamic order in contingent events and relations.

Two things would seem to be required. On the one hand, a way of thinking in which what appeared to be "accidental" would be coordinated with a higher level of order which would give it coherence and intelligibility, "scrambling out," as it were, apparent "irrationalities" or otherwise indecipherable sets of events without any reductionist lapse into causalism or determinism. On the other hand there is needed a way of thinking in which we take the trajectory of temporal motion into our basic equations at all levels, which might enable us not only to grasp the subtle, natural cohesion in contingent events and relations but also to offer some account of the remarkable one-way processes throughout the universe and the equally remarkable ascending direction that characterizes the expansion of the universe toward ever more flexible and open forms of rational order, with which chance and necessity cannot begin to cope. Here we would have a dynamic principle of intelligible order, without determinism, making for increasing innovation, richness of organization, and freedom in terms of which natural laws could be formulated in such a way that they did not conflict with the freedom of the scientific enterprise itself!

Let us now consider these possibilities with reference to the fact that in an outlook characterized by cosmological and epistemological dualism we are apt to overstress the theoretical ingredient in knowledge. In these circumstances mathematics through a process of idealization may acquire easily an autonomous tautological status detached from empirical reality, which inevitably creates difficulties for our understanding of contingence and contingent intelligibility in the universe. I have two points in mind.

On the one hand there is the fact that mathematics is committed to a procedure in which concrete states of affairs in experienced reality are analyzed into discrete particles which have to be represented as identical digital units. Through their symbolic representations these units are ordered in respect of their relative positions to one another and grouped into sets of identities or equations which can be manipulated formally according to sets of rules. This has the effect of dissolving out of our thought the objective connections in nature and therefore of letting actual change or motion slip through the mathematical

system brought to interpret them. Thus classical mechanics was not able to cope with actual time or its motion but only with the acceleration of motion which could be represented in precise mathematical terms. But such an idealized mathematicization of dynamic, contingent relations inevitably yields a necessitarian and determinist view of reality.

On the other hand there is the fact that mathematics is committed to processes of classification and generalization. In employing a fixed notation to supposit for realities or states of affairs in nature, mathematics singles out only those features which they have in common so that they can be arranged into classes for which suitable symbolic expressions are given. The same process is carried into further stages until various classes are generalized into one comprehensive class, the symbolic expression of which is held to be universally valid for all the classes concerned and their component units. Thus mathematical generalization has the effect of rubbing away the differentiating features of the real world and of throwing up a highly abstract uniformity which resolves away all contingence.

Of course that is not what always happens, for even in a profoundly dualist orientation, such as we find in Newtonian science, mathematics remained, albeit in a damaged way, allied to nature, so that mathematical generalization could deploy among its axioms basic ideas and principles derived from nature. However, the universe is so thoroughly contingent in its nature that natural phenomena are found regularly capable of various theoretical interpretations, while mathematical symbolization is so powerful that it can elaborate, even on the basis of axioms connected with nature, theorems and constructs which, while logically consistent and elegant in themselves, far outrun the inherent structures of nature. Hence a choice among various mathematical possibilities must be made, and the criterion to be applied can be only their bearing upon the empirical world.

Now if we generate formalizations of great comprehensiveness, which we identify with laws of nature claimed to be universally and timelessly valid, are we not confusing comprehensiveness with universality and turning natural laws into necessary truths of reason? If on the other hand we accept only mathematical formalizations which are found to be relevant to empirical states of affairs and indeed to concrete instances, then do we not thereby acknowledge that they have a limited or finite validity and that as natural laws they may be held only under conditions of contingency? Judging by the history of modern thought, we recognize that difficulties for empirical science arise whenever mathematics is treated as constituting a tautological system at the expense of damaged relations with the real world. But

whenever mathematics is regarded as intimately correlated with the structures of the empirical universe then by its realist nature it is found to have a reference outside its own system which limits the validity of its formalizations. That insight ranges across modern science from Blaise Pascal to Kurt Gödel.

Correlating Science with Empirical Structures

No one realized this more clearly than Einstein. I think particularly of his lecture before the Prussian Academy of Sciences in 1921, in which he argued that geometry and experience are so closely intertwined that geometry must be regarded as a form of "natural science." That is to say, geometry thus regarded constitutes the epistemological structure in the heart of physics, with which it is so indissolubly united that it cannot be isolated as an independent conceptual system complete and consistent on its own; otherwise it would be empty and irrelevant.

Two of the claims made by Einstein in that lecture are especially relevant to our present purpose: that "in so far as the propositions of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality"; and that the universe is "finite" even if in a certain sense "unbounded."[5] Behind these statements lie the far-reaching implications of general relativity with its disclosure of the indivisible unity of structure and matter, or form and being, within a space-time universe ultimately defined with reference to the finite speed of light. If this is the case then the theoretical components in our scientific knowledge of the universe, which are grounded in its inherent structure or form, are themselves finite and limited, and this forces us once again to recognize the limits of physical laws. This has been reinforced since Einstein by the realization that general relativity, while enabling startling cosmological discoveries, predicts its own limits. This is evident, for example, when we read the expansion of the universe backward to zero points of time and space or when the equations of relativity come up against the limitations of so-called black holes before which our physical laws become critical. Far from detracting from the immense worth of relativity theory this serves only to establish its validity but within the finite range demanded by it.

These developments entitle us to ask certain basic questions. If mathematical propositions bearing upon empirical reality are not certain and if physical laws which they enable us to formalize are limited, then will not final formalization of physical law be impossible, for we are up against limits of a theoretical as well as an empirical kind, that is, contingent intelligibility, inherent in the universe and deriving

from its initial conditions over which we have no control? Furthermore, do we not have to admit the impossibility of any final formal unification of physical law? This might be theoretically possible if we could take infinity into our equations, but that is what relativity will not allow us to do. This is not to deprecate Einstein's long search for a unified field theory, if by that is meant a comprehensive theory in which gravitation theory, quantum theory, and thermodynamic theory are combined and through which we transcend the dualism of particle and field. Indeed perhaps we are now on the way toward that end through new advances in particle theory, in which particles and force fields are ontorelationally interconnected, and in thermodynamic theory now applied to open or nonequilibrium systems yielding a really dynamic view of the universe, and through the startling theory of Stephen Hawking about quantum-mechanical emissions from black holes in which he combines quantum and gravitation theory, not to mention the recent identification of gravitation waves in line with Einstein's predictions. But even so could we ever reach anything more than a coordinated series of equations linking all physical laws, with the recognition that in the nature of the case in a finite universe formalization of physical laws bearing upon reality are necessarily inexact and limited? If the universe is finite and the Gödelian theorems are valid, the utmost that one might expect would be a deeper grasp of the internal interactions and harmonious relations that obtain among them, with considerable simplification of basic laws, yet without being able finally to formalize the ultimate stabilizing and regularizing force of cohesion throughout all physical structures. This is not to admit that in the last analysis the universe is lacking in unity or reliability but that its intelligibility is of a contingent kind characterized by measures of freedom and spontaneity that do not allow for the sort of predictability for which we are tempted to look through our mathematical constructs and necessities.

This line of thought seems considerably strengthened by the fact that time has forced its way back into the essential subject matter of scientific knowledge, that is, not time in the Newtonian sense which was broken down into timeless points whose sequence was regarded as governed by necessary mathematical law, but real time. I think in the first instance here of the point made by Victor F. Weisskopf that atoms and molecules and nuclei all reveal a history, for time enters into what they now actually are.[6] That does not apply evidently to protons, neutrons, and electrons which have no intrinsic properties revealing what happened to them in the past, but it does apply particularly to all self-reproducing structures from the smallest to the largest organisms, for their evolution is written into what they now are

and are in process of becoming. That is to say, the history of matter enters into our scientific understanding of it. I think in the second instance here of the work of Ilya Prigogine and his colleagues in connection with the extension of thermodynamic theory beyond its classical frame of reference to nonequilibrium or open systems in such a way as to account for the rise of new dynamic states of matter deriving from irreversible processes and of a new kind of organization which spontaneously emerges out of apparently random fluctuations far from a state of equilibrium.[7] Here time is given its full meaning associated with irreversibility within spontaneously arising structures and does not merely appear as a geometric parameter externally associated with motion. We have a new kind of time-dependent functional order coordinating space-time to the dynamic processes within the system, and a nonunitary transformation theory is developed to enable a move from a thermodynamic to a genuinely dynamic account of nature. In this way once more a historical element is introduced even into physicochemical description of processes in the universe.

This thermodynamic recovery of real time clearly relates to and reinforces the realization that time has an integral place in the expansion of the universe initiated by the immense explosion from its incredible dense state some twenty to ten billion years ago. The empirical evidence deriving from this, the so-called fossil radiation discovered by A. A. Penzias and R. W. Wilson in 1965, would seem to put an end to theories which in one way or another offer an oscillating or a cyclic, that is, a necessary, account of the universe and establish the fact that the universe is finite in origin and in time and space: It is inherently temporal and limited.[8] Thus the expansion of the universe is to be regarded as a vast temporal singularity, in fact an immense, unique 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 rationalist idea that science is concerned finally only with timeless and necessary truth, for now it seems even more 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.

Now it is evidently due to the irreversibility of time that contingent events which do not happen out of necessity nevertheless have a form of "necessity" and indeed of "necessary consistency" in the sense that once they have taken place they are what they are and cannot now be undone. This applies also to their contingent sequences. It would be a fatal mistake to confuse this contingent necessity and consistency with the hard necessity or logical consistency of determinism according to

which the events had to happen as they did. That fallacy arises from an illusion created by reading the end result of the sequence back along the line of happening into the beginning, which is inevitable when we reverse and logicalize the cause-effect relation in a syllogistic manner, thus tracing the conclusion back into the premises. However, it is in virtue of contingent necessity and consistency that, once we have discovered structures or sequential patterns of contingent intelligibility in the expanding universe which we could not have predicted, we can throw our dynamic understanding of them into a static deductive order with a view to simplifying our grasp of the connections involved by formalizing away distracting features. A typical instance of this has been provided by Weisskopf in which he shows that in terms of six given factors—the mass of the proton, the mass and electrical charge of the electron, the velocity of light, Newton's gravitational constant, and the quantum of action—it is possible to express all the relevant magnitudes which characterize the properties of matter, such as the density and hardness of matter, the height of mountains, the visibility of compact matter, and the size of a star.[9]

It is owing to contingent necessity and consistency which characterize the universe that this kind of mathematical calculation can be made, but there must be borne in mind the inherent limits that such procedures and indeed all scientific analysis involve, of which Weisskopf is very aware. Were we not to follow him in that respect we would sin against thermodynamic irreversibility and the unidirectionality of time, resolving away contingence and converting a dynamic and consistently monotonic account of the expanding universe into a nondynamic and necessitarian account. The universe increasingly manifests itself to our inquiries as an open intelligible system, not one whose immanent processes are closed necessarily upon themselves, requiring from us open-structured modes of thought and formulation to match its nature.[10]

Intertwining of Contingence and Intelligibility

Throughout this discussion I have been arguing that the scientific enterprise and the contingent universe are correlates, for that enterprise is itself part of the expanding universe. The intelligibility of the universe provides sciences with its confidence, but the contingence of the universe provides science with its challenge. It is this deep intertwining of contingence and intelligibility that lies behind the characteristic interdependence of experiment and theory that has marked modern science scince Galileo. Whenever the relation between contingence and intelligibility is damaged, science is tempted to

move in a rationalizing direction in which its conceptual machinery develops an autonomy and momentum of its own; but again and again the advance of scientific inquiry is brought to a halt before unpredictable elements in nature, revealing a more profound and more sophisticated form of organization and calling for a deepening of the scientific enterprise.

Today we have reached the point where scientific investigation of the universe has come up against its finiteness and temporality in the strongest way, while trying to grasp the universe as an intelligible whole. More and more science knocks at the very boundaries of existence, empirical and theoretical boundaries, where the staggering intelligibility of its own enterprise gives rise to the most profound questions. The intelligibility inherent in the universe indicates far more than is actualized in its processes or can be formalized in natural laws, and correspondingly the intelligibility generated in the scientific enterprise points to a dimension of intelligibility transcending it, compared to which it appears relatively elementary.

In traditional thought this intelligible reference of the universe beyond itself has been construed not in a semantic but in a logical way and formulated as an argument through the principle of sufficient reason from the contingent nature of the world to a noncontingent, necessary ground in God. The difficulty with that argument is that such a correlation of contingence with necessity has the effect of finally necessitating down the line every contingent connection leading to it, thus in the last analysis resolving contingence away. The classical form of this argument was provided by Gottfried Wilhelm Leibniz who regarded contingence as something not properly capable of analysis in itself, like an irrational number which nevertheless can be reasonably handled within an infinite series which terminates in the mind of God, the ultimate ground of all certainty, necessity, and rationality. The curious thing is that Leibniz devised the principle of sufficient reason to cope intelligibly with the combination of reason and contingence in motion and operation which the principle of noncontradiction was incapable of doing, but in the last resort his mathematicization or logicalization of the connections led him back into the toils of necessitarianism.

There is no reason, however, why the argument should be logicalized any more than we are obliged to operate with a logicalized relation between the empirical reality of the universe and our scientific understanding of it—the fallacy that Einstein destroyed so effectively. Within the framework of the scientific enterprise the intelligibility alike of the universe and of that enterprise lays hold of our minds in such a way that we cannot rationally resist calling for a

sufficient reason beyond it which not only is congruous with it but requires a contingent order as its intelligible counterpart. Thus we are brought back finally through intelligible contingent relations to the constitutive relation between God the Creator and the contingent universe, the realization of which made the enterprise of empirical science possible in the first place and actually set it on the course of its great achievements.

However, if we are to take contingence seriously without resolving it away, we must face the baffling fact that precisely because of the contingent nature of the universe and of scientific knowledge the reference of their intelligibilities beyond themselves breaks off, so that the questions they raise cannot terminate upon the transcendent, intelligible ground they require in order to constitute the intelligibilities they actually are. What is needed is something like a Gödelian theorem of the universe as an intelligible whole or of the scientific enterprise as an intelligible whole, but that would still not carry us onto the actual transcendent ground from which all our intramundane knowledge would gain its ultimate consistency or coherence. It would be very different if the symmetries of our intramundane intelligibilities were broken and intersected by a symmetry of a higher order which would give them a deeper texture of intelligible meaning, for then the questions they raised would be reshaped and redirected toward their proper end in God the Creator of the universe and its hidden secret.

This is an orientation of thought that one would expect to find mediated through an interaction between natural science and theological science, for theology arises out of the intersection of our human experience and knowledge by divine revelation which thereby takes root in them and opens them upward toward God. As such the concern of theology for the world is not so much with its contingence away from God, which is the preserve of natural science, but with its contingence upon God, and as such it is the science that is unable to halt at the limits that would otherwise satisfy natural science. But since it is the contingence of the realities of the empirical universe upon God that gives them their intelligibility and enables us to grasp their natural and inherent structures, genuine interaction between theological science and natural science cannot but be helpful to both. In this respect the doctrine of the creation of the universe out of nothing can be of special importance for natural science, for in it a new thought world, while having no logical continuity with the thought world arising from our natural sciences, establishes continuity with it and coordinates it with a higher order of meaning in which its own level of meaning is all the more firmly established. Far from detracting from

the contingent, autonomous status of the universe which makes natural science a requirement of the creation, it reinforces our understanding of contingence. That is why a closer dialogue between natural science and theological science may help scientists to remain rigorously faithful to the contingent nature of the universe and its intelligibility in the face of the temptations I have been discussing.

The contribution such a dialogue might make to natural science may be indicated by a brief reference to two points in the foregoing discussion. In the first place, a theological understanding of the created universe as constantly sustained, regulated, and given inner cohesion through the presence of God in his creative power and rationality may be coordinated with the search of natural science for a unified understanding of all structures and laws in the universe which it evidently cannot achieve on its own without distorting rationalization of those structures and laws beyond their finite limits. Thus both theological and natural scientific understanding of the inner consistency of the empirical universe as incomplete and needing to be completed beyond the universe would reinforce each other. In the second place, the theological understanding of the nature of intelligibility in the empirical universe as contingent upon the unlimited intelligibility of God may well help natural science to appreciate in a new way the astonishing capacity of nature to disclose itself in ever new and unexpected forms of rational order of increasing complexity and richness of organization without yielding to the temptation of reductionism. The grounding of the contingent intelligibility in the universe on God does not allow any equation of contingence with deficiency in rationality but rather the reverse, for correlation with the unlimited rationality of God lends contingent intelligibility such a dimension of depth that it exceeds our powers of interpretation and formalization. The inherent difficulty we finite creatures have in knowing God has to do with the excess of his divine rationality over our ability to comprehend it. Correlation with that rationality in God goes far to account for the mysterious and baffling nature of the intelligibility inherent in the universe and explains the profound sense of religious awe it calls forth from us and which, as Einstein insisted, is the mainspring of science.

NOTES

1. See T. F. Torrance, *Determinismus und freie Schöpfung aus der Sicht der Theologie*, Sonderbeilage zum *ibw-Journal*, Dezember 1979 (Dortmund: Deutsches Institut für Bildung und Wissen). Cf. also Michael B. Foster, "The Christian Doctrine of Creation and the Rise of Modern Natural Science," *Mind* 43 (October 1934): 446-68; 44 (October 1935): 439-66; 45 (January 1936): 1-27, for a helpful analysis of Greek conceptions of God and nature and un-Greek elements needed for the rise of empirical science.

Unfortunately Foster does not touch the all-important patristic contribution or deal with the notion of contingent intelligibility.

2. Immanual Kant, *The Critique of Pure Reason*, pp. B 289-90, A 766-B 794.

3. Max Born, *The Born-Einstein Letters* (London: Macmillan, 1969), pp. 221-28 (letters 115 and 116).

4. Werner Heisenberg, *Physics and Beyond*, trans. Arnold J. Pomerans (London: George Allen & Unwin, 1971), p. 243.

5. Albert Einstein, *Ideas and Opinions* (New York: Souvenir Press, 1954), pp. 233, 240.

6. Victor Weisskopf, "The Frontiers and Limits of Science," *American Scientist* 65, (1977): 405-11. Weisskopf does not elaborate the point that neutrons and electrons have no "memory" of their past but shows that with the nucleus there is a part record of its history embedded in it—e.g., a gold nucleus, like that of other heavy elements such as silver and lead, discloses on analysis that it was produced during a supernova explosion. Crystals yield more information, and self-reproducing structures most of all. The brain, which is the last step in the self-producing line, contains the history of all its predecessors but also incorporates the history of its contemporaries by communication.

7. Ilya Prigogine and A. Babloyantz, "Thermodynamics of Evolution," *Physics Today* 25 (November 1972): 23-28; G. Glandsdorf and Ilya Prigogine, *Thermodynamics of Structure, Stability and Fluctuations* (New York: Wiley-Interscience, 1971); Ilya Prigogine and G. Nicolis, *Self-Organization in Non-Equilibrium Systems* (New York: John Wiley & Sons, 1977); Ilya Prigogine, "Time, Structure and Fluctuations," *Science* 201 (1978): 777-85; idem, "The Metamorphosis of Science: Culture and Science Today," *Abba Salama* 9 (1978): 155-83. See also idem, *From Being to Becoming* (San Francisco: W. H. Freeman & Co., 1979).

8. Cf. Stephen Weinberg, *The First Three Minutes* (London: André Deutsch, 1977), pp. 45ff., 52ff., 64ff.; Bernard Lovell, *In the Center of Immensities* (New York: Harper & Row, 1978), pp. 97ff.; Paul Davies, *The Runaway Universe* (London: J. N. Dent, 1978), pp. 31ff.

9. Victor Weisskopf, "Of Atoms, Mountains and Stars: A Study in Qualitative Physics," *Science* 187 (1975): 605-12.

10. Any judgment as to whether the universe is expanding at a sufficient rate to resist any possible gravitational collapse back into an "original" dense state would depend on the knowledge, which we do not have, of the mean density of the matter in the universe. But speculation as to the possibility of an endless series of alternative movements of expansion and collapse, i.e., of a so-called oscillating universe, would have to reckon with a number of questions such as these. Why, e.g., is the fossil radiation from the big bang only 2.7°K which from the inevitable necessities of a cyclic universe would be arbitrary? Why, if there has been (and will be) endless cycles of collapse and expansion, is the universe not far hotter than it is, as one would expect from the increase of entropy through such infinite processes? What value could we seriously give to the contingent nature of the universe upon which all our physics depends if the ultimate necessitarianism of a cyclic or oscillating universe would have the effect—as indeed it would—of having to necessitate all the processes down the line, making us regard contingence in the impossible Kantian way as only under the condition of necessity? In other words, speculation as to an oscillating universe would imply connections in thought that would destroy the foundations of physics we actually work with and invalidate all the results on the ground of which we speculate in this way! It is difficult to avoid the conclusion that there are types of minds which want to get rid of singularities and contingence at any price.