THEOLOGICAL QUESTIONS TO SCIENTISTS

by Wolfhart Pannenberg

In their discussions with theologians few scientists seem motivated primarily by theoretical questions. There is rarely much desire for theologians' help in explaining the world of nature. Rather there is a widespread awareness that science alone cannot cope with the consequences and side effects of scientific discoveries, especially in their technological application. Frightened earlier by the development of nuclear weapons and later by the threat of ecological disaster and by the dangers involved in modern biochemical techniques, many scientists have been led by a sense of responsibility for the application of their work to look for moral resources that can be mustered in order to prevent or at least to reduce the extent of fatal abuse of the possibilities provided by scientific discoveries. At this point then the churches are appreciated once more as moral agencies that should help the human society in responsibly dealing with the potential of science and technology.

The churches should certainly not refuse to face their particular responsibilities in these matters, and theology may be of some assistance here. But in modern society the moral authority of the churches and of their theologies is limited. It has been seriously weakened because the underlying religious interpretation of reality is taken no longer as universally valid but as a matter of private preference, if not as superstition.

This situation has been brought about not primarily perhaps but to a large extent by what has been called the "warfare" of science with theology. According to public opinion in our Western culture this war was lost by Christian apologetics. This does not necessarily mean that the issues have been solved to everybody's satisfaction. On the side of Christian theology there was certainly a lot of bad apologetics involved, especially in the long struggle against the principles of continuity and evolution in natural processes. But there were also important issues at stake. On the side of scientific culture a sort of overkill

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was achieved when scientific inquiry was declared independent of any association with religion. That amounted of course to denying religion its claim on the reality of nature.

It was little comfort in this situation that some religious interpretation of the findings of science was regarded as compatible with science in terms of a private and optional belief. Scientists personally continuing to hold and develop religious views of their work did not alter the fact that, concerning human knowledge of the natural world, religious assertions were considered superfluous. Religion did not make any difference to the scientific description of the reality of nature, and the logical implication was that it had no legitimate claim on reality; the reality of nature could be fully understood without the God of religious faith. In view of the seriousness of this blow to religious truth claims, it would seem appropriate if the renewed interest of scientists in religion and especially in a dialogue with Christian theology were accompanied by some sense of surprise that Christianity is still around. Perhaps Christianity survived only by temporarily separating the outlook of faith from the rational and scientific investigation and description of the natural world. But such an attitude cannot persist because it is profoundly unacceptable on theological grounds.

If the God of the Bible is the creator of the universe, then it is not possible to understand fully or even appropriately the processes of nature without any reference to that God. If, on the contrary, nature can be appropriately understood without reference to the God of the Bible, then that God cannot be the creator of the universe, and consequently he cannot be truly God and be trusted as a source of moral teaching either. To be sure, the reality of God is not incompatible with some form of abstract knowledge concerning the regularities of natural processes, a knowledge that abstracts from the concreteness of physical reality and therefore may be able also to abstract from the presence of God in his creation. But such abstract knowledge of regularities should not claim full and exclusive competence regarding the explanation of nature; if it does so, the reality of God is denied by implication. The so-called methodological atheism of modern science is far from pure innocence. It is a highly ambiguous phenomenon. And yet its very possibility can be regarded as based on the unfailing faithfulness of the creator God to his creation, providing it with the unviolable regularities of natural processes that themselves become the basis of individual and more precarious and transitory natural systems—from stars and mountains and valleys and oceans to the wonders of plants and animal life, resulting in the rise of the human species.

The abstract investigation of the regularities underlying the emergence of these natural forms need not separate them from their

natural context in the creation of God and thus from God himself. But in fact there has been a strong tendency in modern science toward such a separation by putting the knowledge of the abstract regularities of nature to the use of man to whatever purposes he thinks fit. Precisely the abstract character of modern sciences allows the results to be at the disposal of human groups and societies and to serve the most diverse aims. Using scientific research for ever-extended domination and exploitation of natural resources has deeply influenced the direction of research itself. Modern experimental science not simply observes the natural processes but invades them. Thus it does not leave the change of the natural environment to technological application but starts itself on that line by its experimental techniques.

That modern science so easily lends itself to abuse cannot be prevented in principle. It is one of the risks involved in the abstract study of the regularities that either are inherent in nature itself or can be imposed on natural processes. This risk cannot be met on the level of scientific description itself but must be met first on the level of philosophical reflection on the work of science. It is on this level that the abstract form of scientific description must be considered with special attention to what it is "abstracted from" and what is methodically disregarded in the abstract formulas of science. It is on this level then that theologians should address their questions to scientists since God the creator and the nature of things as creatures belong to those aspects of reality that are abstracted from in the mathematical language of science.

There are five such questions that will be raised in the rest of this paper. They have been selected because all of them seem to be of particular importance in the dialogue between natural science and theology. The answers given to each of these questions will contribute significantly to any decision concerning the compatibility of modern science with faith in the biblical God as creator and redeemer of humankind and of his entire creation.

The first and most fundamental of these questions runs like this: Is it conceivable, in view of the importance of contingency in natural processes, to revise the principle of inertia or at least its interpretation? The introduction of this principle in modern science played a major role in depriving God of his function in the conservation of nature and in finally rendering him an unnecessary hypothesis in the understanding of natural processes. Closely connected is the second question: Is the reality of nature to be understood as contingent, and are natural processes to be understood as irreversible? This question aims at the historical character of reality—not only of human history but also of nature—that seems to be specifically related to the biblical idea of God.

The third question is related also to the biblical perspectives of created existence and especially of life: Is there any equivalent in modern biology of the biblical notion of the divine spirit as the origin of life that transcends the limits of the organism? While historicity indicates the general character of reality in the perspective of biblical faith, the divine spirit, at once immanent in creation and transcending the creature, constitutes its living reality in its relation to an ecstatic beyond of self-giving and satisfaction. Since this includes the hope for resurrection and eternal life, the fourth question refers to the relation between time and eternity: Is there any positive relation conceivable of the concept of eternity to the spatiotemporal structure of the physical universe? This is one of the most neglected but also one of the most important questions in the dialogue between theology and science. It is unavoidable if the reality of God is to be related in a positive way to the mathematical structure of the spatiotemporal world of nature.

It will prove indispensable also in approaching the fifth and perhaps the most difficult question in the dialogue between theology and modern science, the question of eschatology: Is the Christian affirmation of an imminent end of this world that in some way invades the present somehow reconcilable with scientific extrapolations of the continuing existence of the universe for at least several billions of years ahead? Just to ask this question in a way that does not simply reduce biblical language to metaphor or dismiss it as mythological is extremely difficult. But this difficulty already arises with the third question regarding the spirit. And from the beginning of such a discourse it lurks behind the very term "God." It is only by exploring the function of "spirit"—involving a redefinition of that term, a clarification of the interrelation between time and eternity, and the issue of eschatology—that the term "God" in its biblical concreteness can be understood in its importance to the world of nature. The first two questions simply provide a starting point for such an exploration, one that will not allow theologians andscientists to talk on so different and unrelated levels as to reduce any agreement in terminology to mere equivocations.

Inertia and Divine Conservation

Is it conceivable, in view of the importance of contingency in natural processes, to revise the principle of inertia or at least its interpretation? The crucial importance of this question in the dialogue between science and theology is generally underestimated. Perhaps this is so because under the impact of deism the relation between God and the world was reduced to the origin of the world and especially of our planetary system. But as early as in the fourteenth century the ques-

tion of the conservation of finite reality had become more prominent in the discussion of the indispensability of a first cause regarding the interpretation of nature. William of Ockham rejected the view of the thirteenth century that in the order of existence the assumption of a first cause was necessary. He argued that in the sequence of generations it was quite natural that the later generation was alive while the former generations were already dead.

In order for a new generation to rise, the continuing existence of a first forefather is not required. In the same way there is no first cause; nor is its continuing existence required in order to account for the continuous rise of new beings in the world. If it were, the chain of natural causes could be traced back ad infinitum. But the need for preservation of what came into existence led Ockham to a different conclusion. If continued existence was not self-explanatory but required the continued activity of the cause that gave origin to the creature, then without the continued existence and activity of a first cause all its effects would vanish, whatever the mediation of their origin might be. Therefore, in Ockham's view, God was still indispensable in the explanation of the physical world because without him no finite reality could persist.

This was changed, however, when in the seventeenth century the principle of inertia was introduced in modern physics. It described an innate potential of persistence for any physical reality, be it in a state of rest or in a state of motion, unless it was disturbed by some other force. The far-reaching impact of this principle on the relation of physical reality to God went largely unnoticed. But the philosopher Hans Blumenberg, in an article published in 1970, demonstrated in some detail that the introduction of the principle of inertia in seventeenth-century physics was to replace the dependence of physical reality on God's activity of continuous creation with the idea of self-preservation, an idea that presumably was derived from stoic traditions.[1]

Interestingly enough, René Descartes considered the principle of inertia still to be in need of some deeper foundation. He traced it back to the immutability of God in his dealings with his creation. Since Descartes still believed that everything created in each moment of its existence depended on the continuous activity of the creator, on his *creatio continua*, only the immutability of the creator could account for the stability in the order of creation, the basic manifestation of which is to be found in the tendency of everything to persevere in the status once acquired unless disturbed by other forces.[2] Later Isaac Newton was content to use the principle of inertia in his *Principia Naturae* (1687) without explicit reference to God (definitions 3 and 4). But Baruch Spinoza was the first to identify the essence of things with their perseverance in being, and thus he provided a metaphysical

foundation for the emancipation of nature from its dependence on divine conservation, on a continuous concursus of a transcendent God.[3]

The emancipation from the creator God entailed in the principle of inertia did not apply only to individual natural bodies and beings which at the same time continued to undergo influences from outside themselves. Even more serious was the consequence that the system of the natural universe had to be conceived now as an interplay between finite bodies and forces without further need for recourse to God. When almost one hundred years after Spinoza Immanuel Kant again used the contingency of all finite reality as a starting point for developing his idea of God, he found himself confined to the puzzlement such contingency presented to human reason; he no longer could claim a direct dependence of contingent reality on God for its preservation.[4] On the other side, Christian apologetics, having accepted the new basis of natural philosophy provided by the principle of inertia, was now left to the unfortunate strategy of looking for gaps in the continuity of natural processes if it wanted to preserve certain occasions for divine interference in the natural world.

But perhaps the principle of inertia or of self-persistence is in fact not as self-evident as believed. If the stuff of the universe is finally made up of events rather than of solid bodies and if the latter are already the products of the regularities of events, then their inertia or self-persistence is no more self-evident than any other natural regularity. The "atomic" view of time and the awareness of the contingency of temporal sequence that kept Descartes from taking inertia as a self-evident principle and led him to seek its basis in the invariable faithfulness of the creator may be, after all, closer to the views of modern science than Spinoza's opposite view. Perhaps after three centuries the conclusion from physical phenomena to an action of God does no longer go so smoothly as at the time of Descartes. But if it depends on a combination of contingent conditions, the phenomenon of inertia may tacitly imply the framework of a field of force to provide the conditions for such a phenomenon to exist.[5]

Contingency, Irreversibility, and History

The second question squarely faces the issue of contingency and regularities of nature in its general form: Is the reality of nature to be understood as contingent, and are natural processes to be understood as irreversible? The combination of the two parts of the question suggests that irreversibility is related to contingency and may be rooted in it. In order to explain this a number of steps is necessary before the impact of the issue on a theological view of the historicity of nature can become apparent.

First, contingent conditions, initial conditions as well as boundary conditions, are required for any formula of natural law to be applied. They are contingent at least in that they cannot be derived from the particular formula of law under consideration.

Second, the regularity itself, which is described by a formula of natural law, can be considered as contingent because its pattern represents a repeatable sequence of events, a sequence that, being temporal, must take place a first time before it is repeated and becomes a regular sequence.[6] The mathematical formula of a natural law may be valid without regard to time. The physical regularity that is described by such a formula is not independent of time and of temporal sequence. But it is only that physical regularity that makes the mathematical formula a law of nature. This suggests that laws of nature are not eternal or atemporal because the fields of their application, the regularities of natural process, originate in the course of time. Thus it also becomes understandable that new patterns of regularity emerging in the sequence of time constitute a field of application for a new set of natural laws such that "the laws governing matter in a higher level of organization can never be entirely deduced from the properties of the lower levels."[7]

Third, if this consideration applies to all natural regularities in temporal sequences, it leads to a general thesis on irreversibility in natural processes. This irreversibility, which is based ultimately on the irreversibility of time, does not preclude the emergence of repeatable patterns of temporal sequence; but such an emergence itself becomes a contingent event. The regularity by itself therefore is only an abstraction—from the contingent process and context of its emergence. Therefore its explanatory potential is necessarily limited.

The irreversibility in natural processes is often argued for on different grounds, especially in relation to the law of entropy. This also has been applied to cosmology and has contributed to relativistic models of the universe such as the "big bang" theory. But the ultimate basis of irreversibility may rather be looked for, as C. F. von Weizsäcker suggests, in the irreversibility of time.[8] Here then contingency and irreversibility may have their common root.

The theological interest in such considerations is due to the biblical understanding of reality as historical. It is intimately related to the biblical understanding of God the creator who acts freely and unrestrictedly not only in laying the foundations of the universe but also in the subsequent course of events. This "continuous creation" is basically characterized by contingency because future acts of God cannot be deduced from past course of events. And yet there emerge regularities and persistent forms of created reality giving expression to the faithfulness and identity of God in affirming the world that he

created. The continuity of this creation can be characterized as the continuity of a history of God being engaged in with his creation. This historical continuity adds to the continuity that is expressed in the regularities of natural processes: While the description of those regularities in the form of "natural laws" abstracts from the contingent conditions of their occurrence, historical continuity comprises the contingency of events together with the emergence of regularities. Thus the category of history provides a more comprehensive description of the continuous process of nature. But on the other hand the continuity of that history in its biblical conception seems to be placed outside the created process, that is, within God himself. Thus we have to see whether this continuity also manifests itself inside the process of nature. This leads to the third question, which is concerned with the spirit of God.

Bible and Biology on the Origin of Life

Is there any equivalent in modern biology of the biblical notion of the divine spirit as the origin of life that transcends the limit of the organism? The question is focused on the phenomenon of life because in biblical writings the work of the spirit relates specifically to life. But it also relates to the created world in its entirety, as the initial words in the book of Genesis indicate.

In biblical traditions, life is not considered as a function of the organism. This constitutes a basic difference from the view of modern biology.[9] The life-giving power is seen as an agent that influences the organism from the outside. When it is called "spirit," one must not think of consciousness and intelligence in the first place. The spirit is rather a mysterious reality, comparable to the wind (John 3:8). When God breathes it into the creature which he built earlier, it comes alive (Gen. 2:7). Thus the person has a life in himself or herself, but only a limited share of it. In the event of death "the dust returns to the earth as it was, and the Spirit returns to God who gave it" (Eccles. 12:7). Further, this view of life as originating from a transcendent source is an indispensable presupposition for the hope in a resurrection to a new life beyond death. Only if the source of life transcends the organism is it conceivable that the individual be given a new life that is no longer separate from the divine spirit, the source of life, but permanently united with it as a "spiritual body" (1 Cor. 15:42-44).

These biblical conceptions quite obviously belong to a universe of discourse different from what modern biology has to tell about life and its origin. But they cannot easily be dismissed as transient with the culture of their time because they possess far-reaching importance for basic affirmations of the Christian faith. If they are to be taken as carrying an important truth, however, it must be somehow present, if only in oblique form, in modern biological descriptions of life too.

Now the living organism, in the view of modern biology, is not a closed system. It transcends itself by inhabiting a territory within an appropriate environment, and it literally lives "on" that environment. In its drives it relates to a future that transforms its own status of life. Sexuality is a particularly powerful manifestation of the ecstatic nature of life.

If one tries to develop a synthetic account of these phenomena, one may be led in a direction similar to that of Michael Polanyi's explanation of individual morphogenesis on the assumption of a "morphogenetic field" that comprises all the boundary conditions of individual development.[10] Polanyi himself does not shy away from expanding this notion in conceiving the idea of a phylogenetic field that governs the process of evolution and that provides a perspective in which individual organisms are to be considered as singularizations; he says that "the evidence provided by the various branches of biology (including psychology)" seems "to cry out for the acknowledgement of a field as the agent of biotic performances."[11] At this point Polanyi's thought meets with Pierre Teilhard de Chardin's vision of point omega at work in the process of evolution as the power of the divine spirit, although Teilhard does not use the field concept in describing the efficacy of that power in the same way as Polanyi.[12]

To the theologian the description of the evolution of life in terms of a generalized field theory must be extremely suggestive because it seems to offer a modern language that possibly can express the biblical idea of the divine spirit as the power of life that transcends the living organism and at the same time is intimately present in the individual. In the perspective of such a field theory of life one may follow Polanyi's "logic of achievement" in the sequence of emergent forms of life and in his final vision of a "cosmic field which called forth all these centres by offering them a short-lived, limited, hazardous opportunity for making some progress of their own towards an unthinkable consummation."[13] But it is not by chance that Polanyi calls that consummation "unthinkable" because neither the eschatological presence of God's kingdom nor the Christian hope for the new life of a resurrection of the dead is imaginable as just another stage in the temporal sequence of the evolutionary process. It adds another dimension, the transfiguration of the temporal by the presence of the eternal.

Eternity and Space-Time

Is there any positive relation conceivable of the concept of eternity to the spatiotemporal structure of the physical universe? As I said, this is one of the most arduous but also one of the most important questions in the dialogue between theology and natural science. If eternity

means the divine mode of being, then it is directly concerned with the question of how the reality of God is related to the spatiotemporal universe. Without an answer to the question regarding time and eternity the relation of God to this world remains inconceivable.

Now eternity has been interpreted traditionally as timelessness, and in this interpretation its relation to time appears to be purely negative. But this contradicts the Christian hope for resurrection because that hope does not aim at a completely different life replacing the present one. It rather aims at a transformation of this present life to let it participate in the divine glory. Salvation cannot mean pure negation and annihilation of this present life, of this creation of God. Therefore in a Christian perspective time and eternity must have some positive relation. This is also implied in the doctrine of the Incarnation since that means a togetherness of the human and of the divine in the person and life of Jesus Christ.

The notion of eternity certainly means unlimited presence. But this need not exclude the temporal that comes into existence once and passes again into nonexistence. The positive relation of the temporal to the eternal could mean that in the perspective of the eternal the temporal does not pass away, although in relation to other spatiotemporal entities it does. On the basis of this it is also conceivable that the lasting presence of the temporal before the eternal God may become the experience of the temporal itself, so that it experiences itself as it stands in the presence of God, vanishing in its contradiction to God or transformed in participation in his glory.

Such an inclusive interpretation of eternity in relation to temporal reality, however, requires a systematic way of relating the extensions of time and space to a conceptual model of eternity. Such a model should be mathematical in character in order to comprise the mathematical structures of space and time. A German mathematician, Günter Ewald of the university of Bochum, is developing such a model.[14] It is based on the notion of a field just as the theory of relativity conceives of the spatiotemporal universe as a single field. According to Ewald this notion can be expanded to include complex numbers beyond real numbers. Since in the level of complex numbers no linear sequence occurs, the transition from complex numbers to real numbers can be interpreted as a transition into spatiotemporal existence. Generally the field of complex numbers in its relation to real numbers can provide a model of the relation of eternity to spatiotemporal events.

It remains to be seen how far the explanatory power of this model goes. Does it explain not only the transition from the eternal to temporal existence but also the manifestation of the eternal within the temporal sequence? According to Christian doctrine such a manifestation of the eternal within temporal reality will occur in its fullness in

the *eschaton* (last times), but by anticipation it occurred in the midst of the ongoing sequence of events in the resurrection of Jesus. This event persuaded the Christian community that the eternal Logos was incarnate in Jesus. The entire problem of miracles is related to the question of the anticipatory presence of the eschatological consummation. But there are also other and more ordinary modes of an anticipatory presence of the eternal in time. According to the Christian doctrine that the divine Logos had an important part even in the creation of the world, the logical structure that became manifest in the person and history of Jesus Christ should somehow be present in every creature. Just as Jesus' identity as the son of God is to be finally confirmed in his eschatological parousia, the essence of all things is realized presently only by anticipation and will be revealed finally in the ultimate future where the temporal will be reconstituted in the presence of the eternal. This is but one aspect of how every creature bears the imprint of the Logos. There also seems to be a tendency toward increasing participation in the divine spirit and Logos in the course of the evolution of creatures, approximating the eschatological presence of the eternal in the temporal. The human mind is distinguished by a unique degree of openness to the presence of the eternal which is expressed in the experience of an amplified presence that overlaps, though in a limited way, past and future events. The participation of the human mind in the eternal Logos through the ecstatic power of the spirit may account also for the possibility and specific character of human knowledge of the created world.

In a trinitarian perspective the work of the Logos and that of the spirit in the creation of the world belong closely together. Can this be expressed in a language that takes account of modern science? If Weizsäcker's suggestion is followed, namely, that the ancient philosophical Logos doctrine can be reformulated in terms of modern information theory, then it does not seem completely inconceivable that a field theory of information can do justice to the cooperation of Logos and spirit in the creation of the world.[15]

Christian Eschatology and the Scientific "Universe"

The last question, that of eschatology, was already touched upon in connection with the work of the spirit and with the transfiguring presence of the eternal in the temporal. But it needs to be raised in its own right because it points to one of the most obvious conflicts between a world view based on modern science and the Christian faith: Is the Christian affirmation of an imminent end of this world that in some way invades the present reconcilable with scientific extrapolations of the continuing existence of the universe for billions of years ahead?

To this question there are no easy solutions. Scientific predictions that in some comfortably distant future the conditions for life will no longer continue on our planet are hardly comparable to biblical eschatology. On the other hand some people are always quick to expurgate the religious traditions from elements that seem to make no sense to one period in the development of scientific insight. Perhaps one should rather accept a conflict in such an important issue, accept it as a challenge to the human mind to penetrate deeper still into the complexities of human experience and awareness. It does not seem unreasonable to expect that a detailed exploration of the issues involved in the question concerning time and eternity may lead one day to more satisfactory ways of including biblical eschatology in an interpretation of the natural world that should take appropriate account of modern science.

NOTES

1. Hans Blumenberg, "Selbsterhaltung und Beharrung: Zur Konstitution der neuzeitlichen Rationalität," *Abhandlungen der Mainzer Akademie der Wissenschaften und der Literatur, geistes- und sozialwissenschaftliche Klasse*, jg. 1969, nr. 11 (1970): 333-83; reprinted in *Subjektivität und Selbsterhaltung: Beiträge zur Diagnose der Moderne*, ed. Hans Ebeling (Frankfurt: Suhrkamp, 1976), pp. 144-207.

2. Blumenberg, in H. Ebeling, pp. 182-85; René Descartes *Principia Philosophiae* 2.36-37.

3. Blumenberg, in Ebeling, pp. 185-88.

4. Immanuel Kant, *Der einzig mögliche Beweisgrund für eine Demonstration des Daseins Gottes* (1763); cf. H. G. Redmann's commentary, *Gott und Welt: Die Schöpfungstheologie der vorkritischen Periode Kants* (Göttingen: Vandenhoeck und Ruprecht, 1962), pp. 142-48, 98-99.

5. C. F. von Weizsäcker, in *Die Einheit der Natur* (München: C. Hanser, 1971), p. 364, calls the principle of inertia "eine Folge der Wirkung des Universums auf das einzelne Urobjekt." This corresponds to the view of Albert Einstein (in his preface to Max Jammer's *Concepts of Space* [Cambridge, Mass.: Harvard University Press, 1954] that Isaac Newton introduced his concept of absolute space "als selbständige Ursache des Trägheitsverhaltens der Körper" in order to secure "dem klassischen Trägheitsprinzip (und damit dem klassischen Bewegungsgesetz) einen exakten Sinn." According to Einstein the concept of absolute space (or its amplification to that of an "inertial system" including time could be overcome only when "der Begriff des körperlichen Objektes als Fundamentalbegriff der Physik allmählich durch den des Feldes ersetzt wurde," since then "die Einführung eines *selbständigen* Raumes" was no longer necessary. Einstein concluded: "Eine andere Möglichkeit für die Überwindung des Intertialsystems als den über die Feldtheorie hat bis jetzt niemand gefunden."

6. See my "Kontingenz und Naturgesetz," in A. M. K. Müller and Wolfhart Pannenberg, *Erwägungen zu einer Theologie der Natur* (Gütersloh: G. Mohn, 1970), pp. 34-80, esp. pp. 65-69.

7. A. R. Peacocke, *Science and the Christian Experiment* (London: Oxford University Press, 1971), p. 87.

8. Weizsäcker, pp. 239-40.

9. More detail on this argument is given in my "The Doctrine of the Spirit and the Task of a Theology of Nature," *Theology* 75 (1972): 8-21.

10. Michael Polanyi, *Personal Knowledge: Towards a Post-Critical Philosophy*, 2d ed. (London: Routledge & Kegan Paul, 1962), p. 356.

11. Ibid., p. 402. For the generalized field concept see pp. 398-400.

12. See my discussion of Pierre Teilhard de Chardin's views on energy, "Geist und Energie: Zur Phänomenologie Teilhards de Chardin," *Acta Teilhardiana* 8 (1971): 5-12.

13. Polanyi, p. 405. Polanyi's use of the field concept should not be mistaken as just another form of vitalism. It is rather opposed to the vitalist assumption, such as Aristotelian entelechy, of a finalistic principle working within the organism. Contrary to this, the field concept involves no finality; nor does it dwell in the organism as some occult quality distinct from its more ordinary aspects open to physical description. The field concept rather offers an integrative framework for a comprehensive description of all aspects of organic life including its interaction with its ecological context.

14. See Günter Ewald, "Bemerkungen zum Begriff von Raum und Zeit in der Physik," in *Gott-Geist-Materie: Theologie und Naturwissenschaft im Gespräch*, ed. H. Dietzfelbinger and L. Mohaupt (Hamburg: Lutherisches Verlagshaus, 1980), pp. 79-86.

15. Weizsäcker, pp. 342-66.