QUANTUM PHYSICS AND THE DIVINE POSTULATE

by Richard Schlegel

In a *Zygon* paper, "The Image of God as a Model for Humanization," Karl E. Peters suggests that God be taken as the process of creation, that he be identified with the coming into being of new entities at all levels of existence—physical, biological, and cultural. God then is "the creative process of random variation and natural selection," and, ". . . if we speak of God as the process of creation, then God, at least in part, is a process that is becoming."[1] Further, Peters brings his naturalistically defined God within the scope of traditional theology by stating that, "formally speaking, the word 'God' signifies that which is comprehensive, related in some way to everything else in the universe, and that which is also most important or of highest value for man."[2] He argues that the creative process is related to all existence and is the most important thing of all because without it nothing else would exist. It therefore fulfills the requirements set for the concept of God and yet is not of the kind of "supreme supernatural being" concept that many people see as a barrier to the use of the term "God."

There is substantial merit, I believe, in Peters's proposal, but also it has, I would say, at least one obvious defect, which I will discuss later. In any event it is unlikely that any single proposed definition of God is going to carry the day in the way, say, that a scientist's proposed definition of a new physical unit might be found useful and in a few years be virtually universally adopted.

Nonetheless each perceptive definition may contribute its bit, adding to the in-practice definition that is operating in religious thinking and attitudes. I will take Peters's proposal to be of this class of helpful statements and use it as one example of a definition of God in our day. Further, I want to write about physics and the definition of God on the root assumption that both physics and theology are concerned with natural reality (broadly conceived as including all that

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exists). If there has been a change in our century in the method and expectation of physics with respect to the knowing of the world (as indeed there has been), then we may look for a parallel in theology—not one that necessarily follows in the footsteps of physics but one that displays alternatives toward knowledge of God that are similar to the alternative new-and-old physics. I believe that we can see readily the theological parallel. We do not thereby come to novel theological thinking, analogous to what we have experienced in contemporary physics. But we do find, I believe, a justification from the new content of physics for an aspect of religious experience—and religious tradition—that is not contained in attempts toward comprehending God in a definition or other verbal statement. In brief, my conclusion will be that there are properties even for a naturalistically defined God which can be gained only through experience, just as, we have found, there are descriptive variables of the physical world which can be ascertained and formed only by observatiation.

Classical Physics and the Definition of God

The science which had its beginnings in the late medieval period, was given its form by Isaac Newton in the seventeenth century, and came to its culmination in the mechanics plus electromagnetic and thermodynamic-kinetic theories of the latter half of the nineteenth century is referred to by physicists today as "classical physics." The structure of this science is illustrated well by the application of Newtonian mechanics to the motions of astronomical bodies. Equations that are central to the theory describe the motional behavior of a particular material body, given initial conditions of position and velocity (and knowledge of the force that is acting, which in classical astronomy is generally that of gravitation). With adequate initial information, "where the body will be" presumably can be calculated for any future time. The theory allows us then to describe a natural world largely without reference to the observing scientist. This is not to say of course that the equations have not been formulated by a human being; and, as specified, there is need for observation of conditions at some instant in order to learn the parameters of the system. But nonetheless we can say that the system is fully independent of the observer in that its dynamic parameters and behavior in time are in no way dependent on the existence of the observing scientist.

The epistemological point of view of classical physics came to be widely accepted throughout the natural sciences. Whether planetary motion, chemical reaction, biological evolution, or even (by some) psychological behavior was under consideration, the model of the

physicist prevailed: The world of natural process constituted a vast domain for man to study and understand. A phrase such as "uniformity of nature" expressed the conviction that the domain could be comprehended within a rational scheme of appropriate concepts (or, if we like, constructs corresponding to natural elements of the domain). As a particular science developed, this scheme presumably would become increasingly deductive in such a manner that occurrences within the scope of the science could be described or predicted precisely, in the way, for example, that celestial mechanics enables the astronomer to foretell a solar eclipse centuries hence.

I have noted then two salient elements of classical physics: (1) a capacity in the science for achieving by deductive (usually mathematical) means as precise a description and space-time localization as desired for individual events and (2) an independence of the natural world studied by science from the operations and thoughts of the describing scientist.

It is obvious that there was and is strong justification for the methodological-epistemological assumptions of classical physics. Calculation from theory (with appropriate corrections en route) does enable a space-traveling vehicle to be sent to the moon and back. And both in astronomy and in daily life we seem to live in a continuing world that in most aspects is independent of our actions or even of our living or dying. It nevertheless will be a central point of this paper that there is now a nontrivial reservation which physics has found against its classical epistemological presumptions. But before entering upon that change in physical thought I want to recall similarities between discussions of God and the outlook of classical physics.

The cited definition by Peters ascribes to God certain of the properties of nature; and indeed it is a modern "scientific" definition in that no qualities beyond the domain of science are proposed. Also the defined God is objective and independent, like the natural world of classical physics. Man is of course a part of that world; the God-as-creativity of Peters's definition presumably acts on man as an individual or as a species. Likewise the physical world of Newton acts on man since he is subject to gravitational force. But the given definition of God (or of the physical world) is without dependence on the observations of the person who accepts it. He or she, I expect, would require experience of the natural world in order to appreciate what is the process of creation that constitutes God, but what God is would not depend on the experience. Similarly of course the scientist must have the guidance of awareness of physical phenomena in order to formulate Newton's laws of motion or to confirm them; but the laws,

or the physical phenomena they describe, are presumably independent of his having any such experience.

The traditional omnipotent God of Christianity, taken as defined by Aquinas, is, I would judge, independent of what man knows quite as much as the physical world of nineteenth-century physics. Man could worship God, be guided by Him, and beseech Him, but it would be unseemly for man to consider God as changing in consequence of man's relation to him. Man indeed was trivial in comparison to God. Yet God was reasonable, and it has been asserted that the concept of an independent physical world, its parts moving and changing strictly in accordance with an ordered scheme, had its origin in the Scholastic rational discourse about God. This is to say that the notion of a natural world regulated by law and discoverable in part through logic-mathematics arose in consequence of the rigorous logical discussions by the Schoolmen of the properties of a controlling, independent God.[3] That there should be grounds for such an assertion is evidence of a parallel between the reality properties given in one of the dominant conceptions of the Christian God and those of the natural world of classical physics.

The second feature of that physics which I have noted is its capacity to give prediction and specification for individual events. This property has a correspondence to the omnipotence of the independent God. Classical physics, as a science, potentially knows everything about the world even if in practice the physicist may not be sufficiently energetic or mathematically skillful to calculate the values of time, position, velocity, and acceleration that characterize the individual particle components of some given event. Here too the scientist is effectively outside the natural world that he is describing, for that world proceeds on its way independently of him. Such "local" disturbances as the scientist may cause with his own physical body are themselves, presumably, part of the vast panoply of determined, calculable natural processes that form the universe. Likewise the omnipotent, independent God can control any jot of the universe. In traditional religious thinking He of course has other properties too—properties of goodness and concern for man that are in no way part of classical physics. But, to repeat, in traditional physics and theology there is a common basic element of man's being subject to a control that is both absolute and altogether beyond his influence.

Other Definitions

Going to other definitions of God we find varying degrees of intrinsic independence from any presumed human experience. I have consid-

ered, with respect to the degree of independence from man's knowledge, the various concepts of God which are presented by Charles Hartshorne and William Reese in the introduction to their anthology, *Philosophers Speak of God.*[4] They give a classification on the basis of whether the following properties are attributed to God: eternal (without change in some or all aspects), temporal (subject to change in some or all aspects), conscious or self-aware, knowing the world (omniscient), and inclusive (having all things of the world as constituents). Generally the conceptions which involve some degree of God's sharing the temporality of the world and which also give the property of inclusiveness imply a God who is not fully independent of man. In contrast Hartshorne and Reese stipulate in what they refer to as the orthodox view that "God is altogether immutable, absolute, wholly independent, and incapable of receiving any good from his creatures."[5]

Any element of inclusiveness—or of what we commonly refer to as pantheism or panentheism—obviously proscribes a God who is strictly independent of man, for if man is part of God then obviously God's nature is dependent to that degree upon what man may be. If God is limited to certain aspects of man, then we may have an extreme form of dependence in what can be called a temporalistic theism. Hartshorne and Reese find such a concept in the God "as creative event" of Henry Nelson Wieman.[6] Here creativity is not the universal natural process on which Peters rests his definition. Rather what is referred to is creation as it occurs in communication among human beings, giving rise to the good of the world relative to humans. What creates this good is "suprahuman" but is not transcendent in the sense of being nontemporal, nonspatial, and immaterial.

A God concept such as Wieman's illustrates that definitions which do bring man's behavior directly into the nature of God are present in contemporary religious thought. Association of God with a worldwide natural process of which man is perhaps only incidentally a part, as in Peters's definition, does not lead to the property that God is what man makes Him; even though His independence is not complete, as in the "orthodox" view, He is in no way essentially dependent on what man is. But, in a theology such as Wieman's, man helps form what God as the creative process is—not in so relatively objective a sense as man's biological organism being part of God but in the sense that man's intellectual and cultural behavior is essential to the nature and work of God. (It is of course not just man's actions and institutions, sociologically considered, that constitute Wieman's God; at the least the strong value component that occurs and is felt by man is part of the defined entity.)

We do have then a spectrum of concepts of God with respect to the property of independence of man. The independent God, corresponding to the independent natural world of classical physics, is an expression of a view of divine reality and man's relation to it that is still important in Christianity. In Peters's definition even though God is temporal and is altogether in the natural world He is not primarily a creation of man. And, we have seen, there are other conceptions, such as Wieman's, which do suggest a much more direct dependence on human beings. The supporters of this last type of definition can find in contemporary physics some congenial similarity—an outlook that requires also for physical reality a dependence on man. We will see too that concomitantly there has come into physics a significant diminution of its predictive, descriptive power. There is support then in our knowledge of the natural world for doctrines which see a transfer of power over events from the orthodox, omnipotent God to one who is in some degree a consequence of man's knowing him.

The Principle of Superposition: Complementarity

In an earlier paper, "Quantum Physics and Human Purpose," I gave a nontechnical discussion of the observation and theory which have led physicists to a belief about the relation between man and the physical world that is very different from that of classical physics.[7] The reader who is not conversant with quantum physics and its epistemology may wish to refer to that paper. Here I shall present without justification only salient elements of the new physical philosophy.

In classical physics a physical system (e.g., a material particle) is described by a set of dynamic variables, such as position and velocity, which have definite values. There is no thought of allowing more than one magnitude for a variable at a given time. Indeed common sense rebels at the suggestion of doing so, for our experience with everyday objects tells us that they have definite, unique location and motion at a given instant of time. Quantum physics, however, has been forced to the principle that objects on the level of the very small must be regarded as existing, under appropriate conditions, with dynamic variables which have more than one magnitude or indeed even a continuum of different values. "Very small" here means on the level of individual atomic entities, such as electrons, protons, neutrons, and photons (roughly, for particles, spatial dimensions of about 10^{-13} cm.).

The possibility of an object's existing with different values for a given descriptive variable or, as it is said, in different states is referred to in quantum theory as the principle of superposition. A physical

system is not constrained to have only some one set of values for its dynamic properties but may exist in a superposition of states; in classical physics these states would be physically inconsistent with one another (e.g., being in two or more places at a given time). There are many examples in observational physics of systems whose behavior can be understood and correctly described only by use of a superposition of states. Electrons or photons, for example, in the phenomena of interference (illustrated by such everyday effects as color variations on oil films or bands of darkness and illumination when light comes through a very small opening) must be regarded as being in different positional states as they pass through the relatively large-scale physical system that engenders the interference effects. Thus in the double-slit apparatus so familiar in elementary-physics instruction the photon must be in a superposition of states that brings it through both slits. To give another example, a proton, which can spin about its own axis in a positive or a negative sense, the latter being exactly opposite to that of the former (as clockwise is opposite to counterclockwise), must be regarded in certain scattering interactions with other protons as being in a superposition of + and − spin states. Or, to give yet another illustration, any elementary particle, such as an electron or a proton, is found only under highly special circumstances to be in a state of some one given velocity (e.g., 1000 meters/sec.). Generally it is in a superposition of various velocity states. Even the matter and antimatter states of a particle in at least one instance have been found experimentally to combine into a particle existing as a superposition of those two states.

It is by appeal to the superposition principle that physicists have been able to explain such paradoxical (in classical physics!) phenomena as those which give what is known as the wave-particle dualism. The electron, which because of the interference effects that it displays must be regarded as being able to pass simultaneously through several positions in a crystal lattice, is said thereby to propagate as a wave; yet in an interaction, such as with an atom or molecule, it transfers its energy and momentum in the localized fashion of a corpuscular particle. Its "wave" property consists of its being in a superposition of different states, each one taking in through a different position in the crystal.

Of course it might be said that in invoking the superposition of states one is only transferring the wave-particle problem to the superposition principle. In fact, though, most quantum physicists do not today see any paradox in either context. Their root appeal is to the fact—as indicated by the superposition principle—that on the spatial

level at which quantum effects are occurring the space-time description of ordinary experience is no longer valid. The results of quantum theory tell us that we cannot make the mesh indefinitely fine in assigning position and time and motion variables, that as we come to smaller and smaller dimensions we find that inevitable uncertainties appear in our measured variables. We may try to puzzle out precisely what happens to a particle such that it is able both to pass through various positions in space and yet to be a localized corpuscle, but in making this attempt we find intrinsic barriers to the mapping of the particle's space-time behavior. It is truly as if nature has put a limit on the indefinite divisibility of space and time and yet also, by introducing new dynamic properties of matter, has foiled the speculative thrust which asks, "How can fineness of localization be limited?"

The physicist's trump card in these investigations is Werner Heisenberg's uncertainty principle. Any experiments which in actuality or in principle seek to examine the detailed behavior of a particle are limited in their results by that principle. Thus an apparatus which is set up to measure at which position an electron actually passes through an interference-producing crystal will be able to do just that, but only at the expense of putting the electron into a superposition of velocity states such that it will not have that well-defined velocity, of limited uncertainty, which is physically necessary if we are to obtain interference effects.

The illustrative example just given may serve as an instance of what Niels Bohr introduced into quantum physics as the complementarity principle. This is an assertion that classical modes of description which in one context (physical situation) are suitable may not be used in a different context and that there is a necessary exclusion existing in any one situation between conjugate modes which are related in the sense of the principle. Thus the description of an electron in terms of its space-time location forbids achieving with the same physical arrangement a description of the electron (without uncertainty) with respect to its velocity-energy properties. Using the "state of a system" concept, we can say that the complementarity principle requires that a system cannot simultaneously be in a measured state with respect to all of its dynamic variables. (This restriction is not to be confused with the superposition of different states that is allowed for some one variable.) If it is found to be in a velocity state, it cannot be in some one position state at the same time. Or, to give another example, if an electron's spin (angular momentum) along one direction is determined, there can be no simultaneous determination along a perpendicular direction; the electron, that is, cannot at the same time be in a

determined spin state with respect to two axes perpendicular to each other. (Classically of course we see no objection to a body's having two such spin components, just as we see no problem in its having simultaneously a determined position and velocity.)

For two variables which are "complementary" in the sense of the principle the question of which one is applicable to a system is determined by the manner in which the system physically is handled and observed or, it is sometimes said, by the "preparation" of the system. If a beam of electrons is put through a velocity selector and then into a diffraction apparatus by which the electrons' wavelength is determined, the velocity variable (whose magnitude may be obtained from the wavelength) is the relevant one for the state of the electrons. If alternatively the beam is directed toward a photographic film which will record each electron as a spot when it interacts with it, the position variable is the one characterizing each electron's state. The interaction event destroys any intrinsic velocity state.

Bohr himself initiated an application of the principle of complementarity beyond its rigorous definition in quantum physics. Thus he suggested that there may be a disjunctive complementarity between human participation in any activity and thinking about that activity. Also a complementarity exclusion might exist between investigation of physical aspects (e.g., neural processes) of thought and the direct, subjective experience that constitutes mental life. Papers in *Zygon* by Hugo Adam Bedau and by D. M. MacKay have examined an extension of the complementarity principle to religious and scientific thought, taken as two different modes of understanding.[8] The reserve with which these two authors see the principle as contributing to an analysis of the demarcation between science and religion is, I believe, well founded. Disjunctive complementarity is a valuable notion and probably applicable to a degree in many kinds of description. However, it is not clear that between the approaches of science and religion there indeed is that firm and intrinsic mutual exclusiveness which nature does seem to maintain between some sets of dynamic variables in the space-time of the microdomain.

Quantum-Level Subjectivity

The limits which quantum physics has found for detailed space-time description and the property of superposition of different (classical) dynamic states for a system are key elements in the deep alteration which physics has brought into our natural philosophy since 1900. We may note too that obviously the classical-physics principle of strict determinism of state has been changed, for if we cannot have exact

description on the microlevel and also if there is a possibility of more than one value for a dynamic variable we readily see that we have no basis for the exact determination of the state of a system from earlier (exactly determined) states. In other discussions the causal indeterminacy property of individual quantum-level events may be of primary interest. Here, however, our major concern is with that epistemological property of quantum physics which supports an element of subjectivism in a description of God.

Even though a microentity can be in a superposition of different states, corresponding to different values for a dynamic variable, the observation of the entity with our macroscopic instruments must show it to be in some one state with respect to that variable. An electron must be regarded as occupying various positional states (as being spatially extended) as it passes through a diffracting crystal, but it is at some one point when it is observed in its interaction with a photographic film or other position detector. In quantum physics generally observation plays an essential role in the determination of the state of a physical system. In describing the electron in our example, as it passes through the crystal we regard it as being in a superposition of different states because of the observed interference effects, but when it is manifest to us, in experience, it is in some one single (approximate) state. In classical physics we at all times considered the electron to be in a single state, and further we believed that in principle we could predict accurately when and where it would interact with a detector. Although useful for confirming prediction (and for getting some initial "fix" on a system), observation then was not continuously necessary for description in prequantum physics. But quantum theory tells us that it is only by observation that we can learn the when and where of an individual quantum-level event. As long as the electron is in the superposition of states, without the interaction of a measuring (observing) apparatus, the equations of the theory will tell us the behavior of the states. Those same equations, however, will give only a probability measure for the electron's being actually observed in any one state (e.g., at any one spatial location). All the computers in the world cannot improve on this situation. Only observation of the event will give us a space-time description of its occurrence.

A second example is provided by the decay of a radioactive atom. We know, to take a specific case, that radium emits alpha particles (helium nuclei) and thereby changes into radon. The transformation rate is such that one-half of a given sample of radium will have become radon in 1,620 years. The application of quantum theory to the behavior of an alpha particle within the radium nucleus gives a good

account of the transformation, including prediction of the 1,620-year half-life. But, given a single radium atom, there is no theory whatsoever that will predict exactly at what instant it will emit an alpha particle and become radon. The scientist who would know can only set up a detecting apparatus and wait for the event.

We can say, because of the necessary role of the observer, that quantum physics is subjective or dependent on the observing subject in a way that classical physics is not. A description of individual events in quantum physics requires an observation of every event. Hence physics cannot be conceived as a body of equations which will yield a description of the events of the world once appropriate initial conditions have been ascertained. Instead physics is a science that requires the presence of an observer or some surrogate apparatus at the time and place of each individual event which is to be described.

The subjectivity that thereby is introduced into physical science on the quantum level is in fact more than epistemological; that is, it implies more than a need for an observer if events are to be known. There is a genuine ontological subjectivity since the interaction that occurs with observation by a subject is a necessary element in the creation of the event. Generally, to repeat, the microparticle that is to be observed is in a superposition of states with respect to the dynamic variable whose magnitude is to be observed; it is only with the act of observation (an interaction with the particle) that the microparticle goes into the single state that is observed. Think again of the electron passing through the crystal. We cannot say that it is moving along some single trajectory, the location of which we do not know but can ascertain by making an observation. It is, as the electron interference experiments show, in a superposition of states of different trajectories until observation determines it to be at some one location. Physicists speak of a particle or other simple system that is in a superposition of states as being projected into some one state by the act of observation. Or the more vivid phrase "collapse of the wave packet" is used, referring to a particle as being effectively a packet of waves of different wavelengths (velocities) before observation initiates the "collapse" to a corpuscular particle.

The act of observing therefore not only is necessary for information about an event but also contributes to its coming into being. Suppose that at time t an electron is observed at point P. Can we say, "Even if it were not observed, the electron did pass that point"? In classical physics, yes, but in quantum physics, no. The occurrence of the electron at (P,t) was in part a consequence of a detecting apparatus being at (P,t). Without it the electron was in superposition of various states

at time t, and at most we could say only that there was a certain probability of its interacting with an observer at P.

Our world view then indeed has changed with the establishment of quantum theory. Physical science has found that it cannot be omniscient with respect to individual events but must be content to record them as they occur. And the event is not an objective occurrence, proceeding or happening independently of man's observation. His act of observing has been an element in the creation of the event. In the words of Heisenberg, "science no longer confronts nature as an objective observer, but sees itself as actor in this interplay between man and nature."[9]

One might well ask, "How could classical physics have been so misguided if experiment does require the outlook of quantum theory?" The answer is that quantum physics, as indicated, is based on what we have learned about events and structures on the level of the very small (atomic dimensions and less). When a system consists of many individual particles such that it is of the size of the bodies for which classical physics was formulated, we find that the relevant equations of quantum theory do generally become equivalent to those of classical physics, we regain (approximate) causal determinism, we lose such phenomena as wave-particle dualities which involve breakdown of precise space-time determination, and we are able to describe events and properties as existing and being predictable independently of our observing them. Nonetheless our understanding of many of the phenomena of nature rests on what is occurring on the quantum-scale level. The emission and absorption of radiation, the chemical properties of the elements, the interactions of elementary particles, the behavior of matter at low temperatures—these and many more have been elucidated by quantum physics. But it is true too that in some instances individual quantum events in nature can have substantial macroscopic effects. The occurrence of a mutation in an egg or sperm cell, for example, is a quantum-level change which can alter profoundly an adult biological organism which develops from that cell.

Quantum Physics and Definitions of God

Let us assume that science and theology are both concerned with what exists and with its properties of general importance to man and nature. A way of putting this assumption with a popular term would be to say that both scientist and theologian are seeking ultimate reality. We might dignify the assumption with a name, the divine postulate. In an acceptance of it we can lend, I believe, religious significance to physics (or science generally) and also emphasize the role of

natural experience in theology. This is not to say that we should expect physics and theology to find the same basic world properties. The physicist looks for features of process and structure that obtain for nature everywhere: for galaxy, biological cell, and elementary particle. The theologian, I would take it, is more concerned with the role and response of man as a whole person in the universe. But our assumption forbids that religion can center on a spatial heaven which astronomy nowhere finds; it also forbids perhaps that physics may construct a mechanical cosmos which has no place for consciousness or aspiration.

If we accept the divine postulate the discoveries of this century in quantum physics surely must affect our conceptions of God. The independent, all-knowing deity of Christian orthodoxy is no longer within the possibilities allowed by the postulate. The individual events of the universe are not predetermined and cannot be foretold. To a degree then for God as for the physicist the events of the universe must be experienced to be known. This does not mean that the universe is one of chaos, for, as I have noted, the patterns of large assemblies of microevents are found to have the ordered structures and behavior that led to the deterministic classical physics. But because of the freedom from a precise and determined occurrence for individual microevents there is possibility for basic novelty in nature. The development of new forms in the natural world— the existence of evolution in a broad sense of the word—is therefore reasonable in terms of quantum theory in a way that it is not in a completely mechanistic universe. Likewise the appearance of surprises, of the unexpected turn of events, or of the person with unusual talent or character seems to be in keeping with there being an element of the unpredictable on the level of basic process in nature.

A definition of God such as that given by Peters seems to reflect, deliberately or otherwise, the change from classical to quantum physics. To identify God with creation is clearly in accord with our postulate because nature does so abundantly display creation and becoming. This creativity is obviously apparent in human activity, in the birth and development of individual living organisms, and in the natural emergence of new physical structures and biological species.

I suggest, however, that to identify God only with the novel and creative does not give as much as needed to our concept of that which is of highest value. The processes of nature exhibit stability as well as novelty, and properties that fall under both of these broad rubrics are necessary if we are to have our world. At as small a level as an individual atom we find stable patterns for extranuclear electrons in given

energy states. Interaction, as in chemical change, may disturb the patterns, but then a new stability may be achieved for a period of time; and if energy-wise the atom again goes to the states first considered there will be a return of the initial pattern. Passing to the level of human beings, we can note the relatively unchanging round of physiological and behavioral activities that form a warp for the woof of growth and achievement. And in society there are the institutions which, even though changing in time, also give necessary stability. The existence of order in the world is as notable as the appearance of meaningful change in that order; both seem to have been won from chaos.

The omission of stability is the defect to which I referred in the introductory discussion of Peters's definition. One can object that stability is the dross of existence, whereas creation is the valued property with which God should be identified. But I say that both are necessary and also that we do indeed find satisfaction in the repeated occurrence of events; existence is itself good.

The God I have been discussing is limited in knowledge and power in accordance with the statistical, probabilistic properties that quantum theory finds for nature. However, an interesting proposal has been made by George A. Riggan for a defined God who, even within the concepts of quantum theory, would escape the probabilistic limitation and would have the omniscience of the traditional orthodox God. We recall that microsystems generally exist in a superposition of states. Riggan's proposal is that God be associated with the superposition of states of the evolving universe. Observation, I have noted, leads to the manifestation of some one state of a system. God, however, on this proposal contains all states. "Hence," Riggan writes, "as the superposition of the states of the cosmos, *god* is immutable. In this meaning *god* is also omnipotent. For all possibilities, potential or actualized, are embraced in the superposition of states of the cosmic ecosystem. Further, although human knowledge can neither fully grasp nor describe that superposition of states, that superposition itself nevertheless embraces all knowing and all fantasizing, whether actual or potential and whether human or prehuman. Hence *god*, thus defined, possesses all possible knowledge and in that meaning is omniscient."[10]

We must realize that with Riggan's proposal, and if we also accept the divine postulate, each state of a superposition exists forever; there is not (in his God) intrinsically with interaction-observation the "collapse" of a set of states of a particle or system into the single state that is the manifest individual event. God then can be omniscient because

he knows all states and unlike the physicist need not ask questions about probability of transformation to any one observed state.

It is noteworthy that the theologian Riggan has been led to his supposition, I presume, at least partly on philosophical-religious grounds, whereas a parallel speculation also has been presented in pure physics. In the so-called many-worlds interpretation of quantum theory initiated by Hugh Everett III the hypothesis is made that there is no "collapse," or projection from a superposition of states into some one (observed) state.[11] Instead the universe divides such that each state of the superposition becomes manifest to an observer as a single state. This required observer for each state is present in consequence of the division of the universe. Thus suppose an electron is in an apparatus in a superposition of states such that it can be observed to pass, with a probability of 1/5, through any one of five different slits. The Everett hypothesis is that on passage through the slits the observer becomes five different observers, each with his own total universe; each observer, however, finds the electron to pass through a different slit. No one observer of course knows anything about the other four observers (and universes) which also have come from the five-fold division of the original observer (and universe). Considering the number of quantum-level processes which at all times are occurring in the world, with projection from a superposition to a single state, the multiplication of universes obviously would have to proceed with enormous increase.

The many-worlds hypothesis is rather outrageous; and yet within the structure of quantum theory it is logically impeccable. Its supporters—and there are a few—point out that it makes quantum theory completely causal in that there is no break in the rigorous, deterministic mathematical description of nature. There is such a break in orthodox quantum theory in that it fails to describe except with a probability measure the transition from a superposition of states to an observed state, but in Everett's interpretation each observed state is determined smoothly as a development of some one state of a superposition. Of course there is a high price indeed for this determinism. One can well ask, "In what reasonable sense is it causal to have the entire universe divide?" Certainly there is nothing elsewhere in natural science to support the existence of such a division.

I shall not further pursue the Riggan proposal except to say that it should be—if, again, we accept the divine postulate—subject to support or discredit from investigations of nature. The many-worlds interpretation may be taken as a line of support but, I would judge, not

one that is highly convincing to most people. However, there may well be, I recognize, other ways than the one I have taken in following the proposal. I will conclude nonetheless that as of now there is no obvious, strong empirical ground for discarding the warrant that comes from quantum physics against a deity who knows and controls every detail of the universe.

Subjectivism in the Definition of God

There is a further, clear implication in quantum theory for our concept of God, assuming that there are the common existence properties for nature and God that my postulate requires. We now need not call upon any exotic speculations regarding quantum theory but can build our case with reference to central aspects of established quantum physics.

The orthodox definition of God as independent, omniscient, and omnipotent, as well as those offered by Peters and by Riggan, assumes that it is possible to give an objective definition. Among the definitions that I have considered, only that of Wieman has a full dependence on actual events, on certain kinds of experience among people. The guidance that we have from quantum theory tells us that nature is entirely determined only by reference to the experience (the observations) of the scientist. We can expect then that a definition of God cannot be adequate if it is given as objectively valid for all persons or things, independently of their particular experiences of God.

To what aspects of experience might we then think to look for the subjective content of a definition of God? Obviously not primarily to the microdomain where the physicist in his study of general properties of matter finds dependence of event on the observer but rather among aspects of experience that traditionally have been of concern to religion. It is when asking questions with respect to direction of life—who or what is important, what my goals are, how I make choices that are of critical significance, what is of intrinsic good and a source of satisfaction—that men and women look to their religion and their God. My thesis is that as one goes through the thinking and feeling involved in answering such questions one contributes essential elements to the definition of God. One forms Him for one's self, not from nothing but from the being and possibilities that exist in the universe and in particular in one's own person.

Without the subjective contribution a definition of God would seem to be far too abstract, too separated from immediate feeling and conviction, to allow the God concept, however named, to be a force in one's life. Men and women guide their actions with the assistance of

reason, but we well know that basic conviction and emotional affect, supported by the fundamental biological impulses, are the factors of movement and achievement. In developing his or her patterns of thought and behavior, as life goes on, a person comes to a religious outlook operationally defined even if not explicitly verbalized. Here, I would say, the person's God has been defined somewhat differently for each man or woman but always with a role of determining behavior and personality.

Without this subjective element in the definition of God I take it that people would lack the capacity for achievement, or for sacrifice, or deep love, or courage. In probing one's self and finding grounds for a nonroutine kind of behavior one is meeting and forming a part of God. The person and situation are, to use an analogy to physics, the laboratory apparatus which determines the properties that the observed particle will have, but here it is the human character which determines action or thought or feeling that is formed and is an element in the divine nature of reality. In traditional Christianity there of course is also the essential role of the faith and love that a communicant has for God, for, even with the orthodox independent God, religion is largely subjective in the sense that it is largely a matter of what a person feels. But there is the difference that the God of orthodoxy is regarded as unaffected by man and hence is not in part created by a person as his or her life is formed and lived.

Does our subjective aspect require that actions or feelings which we consider to be bad are also consequences of a person's subjective definition of God? The answer is no, for the reason that we do not want to assert that God is defined only subjectively. Here again an analogy with the situation in physics may be helpful. We remember that for systems of many particles there is in general a correspondence of the results of quantum theory with the equations of classical physics. I say that likewise the experiences of God of many people tend to a common definition, or at least toward containing certain properties that are present in most of the definitions. Hence the traditional property of God as goodness is supported by common experience. The requirements of such a God on behavior are a proscription against subjective definitions of God that lead to nonvirtuous action. There is always, though, the possibility for individual differences. In a given circumstance thievery, for example, may seem to be good even though counter to a general condemnation by the commonly accepted definition of God.

Are we merely saying that people in a given society set up mores and laws and that these may be given the religious sanction of a God

concept so as to keep in line the person whose impulses or character move him otherwise? We now are asking a root ontological question about God. In this and the past few centuries, in the conflict between natural-science investigations and the traditional definitions, the objective definition of God has not fared very well. As in Peters's definition, for example, we can associate God with some aspect of the objective natural universe, but we do not thereby gain the meaningful properties that are found, for example, by a Christian believer in his God—though perhaps we do somewhat better with the subjectively defined aspects of God. The personal questions of direction and meaning are the very heart of one's life. To find God there, to say that he is the source of proper direction for one's self, is to identify him with elements of experience that, quite as much as the material bodies of the physical world, must be given the grace and power of existence. There is then a formation of part of the divine in each person as the particular subjective definition is developed.

Common to most definitions, the elements which we say can support an objective definition should point to properties of the total universe, including man and his culture. In particular, if the divine postulate is valid, the properties that are found scientifically in the nonpersonal natural world should confirm and reinforce those that come from religious definitions of God that refer to the behavior and feeling of human beings. The degree to which there is today such a concordance is perhaps not impressive. But as we learn more and more about the relations between the biological-cultural aspects of man and the properties of the physical-chemical world, possibly we will gain perceptive understanding of how, say, man's aspiration or the deep satisfaction in some moment of awareness of his world is related to that which natural science finds to exist.

I submit that in any event we gain with the findings of quantum physics a new and significant element of harmony between the epistemology of science and that of religion. The center of religious conviction generally is in the direct experience of persons, whatever might be the objective definition of God provided by doctrinal context. We now can assert that immediate experience is fundamental in the nature of things—for the physicist in ascertaining what occurs on the microlevel and for the individual human being in achieving direction and conviction about behavior and values. The world, for the elementary particle and for the man or woman, finds what are its particular realizations only as they occur; there is no preset pattern to be unfolded as events come into being.

The role of conversion and revelation in traditional religion, so well described by William James, could be regarded as supported by the

necessary place of observation of event in the epistemology of physics I have been describing.[12] If, however, one wished to remain skeptical of the substantive religious content of revelation, the point could be made that the manifest divine properties of the revealed divinity are usually strongly determined by the religious culture of the receiver. A counter argument of course would be that God might choose reasonably to operate in the words and symbols that are known to the person that is given the revelation. I shall not attempt to pursue this point. Rather, staying with a generally naturalistic point of view, I can say that the experiences referred to in the subjective definition of God are part of daily living for all active human beings. For every person there is a formation of thought and action by his or her particular culture, but also there are the essential biological and physical elements. It is, I am suggesting, in the formation of guiding principles for living with all these factors that each person achieves the subjective aspects of the definition of God.

The whole interaction of a man or woman with the world therefore is contributing to the definition. Explicit, verbalized ideas and attitudes gained from fellow human beings obviously play their role. But there are also the impulses, the satisfactions, and the aspirations coming from one's body and mind—from nature itself—that enter into what one forms into a subjective definition of God. Not only may there be little or no verbal definition, but I would think that we may extend the existence of an operational definition into the nonhuman biological realm. In its pattern of behavior and goals any animal is expressing the existence both of guidance and of intrinsic value or good that are present in the universe. These may be regarded as direct experience of God and hence as contributing to an organism's operational definition of him.

I am proposing that the divine element in nature is manifest both in patterns of behavior that are established and in desired novel actions or efforts toward new patterns. Speaking again of man, I find that he has (at least it so seems to me) more opportunity than other terrestrial animals to express and define his own life. In taking up the parallel with quantum theory I am emphasizing that God has not determined what each person shall do. Rather each person in developing his life does form his own definition of God and hence determines part of the divine aspect of nature.

Should God Be Defined?

I have assserted, with the divine postulate, that empirical findings of physical science have relevance for man's conception of God. The

subjective definition that I have proposed is not an innovation in contemporary theology. I have noted Wieman's concept, and the widely influential ideas of Whitehead—specifically his consequent nature of God—come to mind.[13] Quantum physics may be seen then as reinforcing a line of current religious thought. But the reader whose judgment is generally against acceptance of any religious doctrine might well want to ask, "If one accepts a naturalistic, scientific point of view, what is gained by attempts toward defining God within that philosophy?" I want briefly to discuss this question, and I will attempt to do so without reference to various metaphysical arguments which find God as necessary for completion of a rational interpretation of the universe. (I do not intend thereby necessarily to dismiss such arguments.)

It is easy to appreciate how a good-spirited person can find grounds for rejecting any concept of God. Because so much superstitious belief, meaningless language, and cruel action have been associated with ideas of the deity, there is substantial appeal in an outright renunciation. This may be particularly so for one of critical mind who is absorbed in and satisfied by scientific studies. Even though a world constituted only by that which has been established by science may be truncated in that it stops where our firm knowledge ends, at least, such a person may argue, it has not been extended with hypothetical entities of speculative and emotional construction. This same person, however, if open-minded, can find impressive evidence of the many-faceted goodness that conceptions of God have inspired and supported, both in individual persons and in institutions of society. Any attempted weighing of ethical superiority in order to make a decision between belief and nonbelief in God probably would reflect only the bias of the observer.

I would rather point to the human conscious life where we have localized the individual person's subjective definition of God. Everyone, regardless of attitude toward religion, must make decisions about what he values and what he wants to do, decisions about where life has meaning and how it is to be lived. A ground for associating principles (the reasons) for these choices with God is that so much of what is of the highest and best in our experience bears on these principles. The ecstasy of love, the satisfactions of achievement, the wonder of understanding and discovery, the keeping to difficult but dutiful behavior, the sheer pleasures of being alive and of being aware of nature and of art—these are factors in what may be seen as the divine aspect of nature that brings to us qualities not contained in objective description of the world and yet all-important to us. We can

believe that without them perhaps there would be no happiness and no creativity, and the world actually would be the unembellished machine of classical physics.

We can see in human inspiration or conviction the operation of the divine aspect of nature. Likewise we draw upon it in self-questioning or in considering critical decisions. Since this aspect is formed in part by the person, it is proper to say that in prayer one in fact is communicating with God in that one is calling upon one's own divine capacities and principles for guidance or help. These as elements of man are part of the natural world but a part with some attributes that so far have escaped the much less than complete description of science. So too when a man or woman has an idea or goal that it seems must be pursued it is legitimate to say that it has divine sanction, if we consider that there are elements of man's nature which have divine properties and give him a basis for forming his subjective aspect of God.

Some people still may wish to abjure any reference to God, to deny that any part or aspect of the universe usefully is given that name. The formation of character, the appearance of heroism or of genius achievement, the reach of human thought and feeling—existents such as these may be held simply as part of the way nature is, and nothing in the universe should be put in the tradition of beyond man's ordinary world connoted by the word "divine." I do not believe there is any convincing argument that can be made against those who wish to take this stand, and I presume one today can be quite as responsible to the possibilities of life without thinking explicitly in terms of a God concept as when one does do so.

However, with the exclusion of any concept of a divine aspect of nature one does lack a rubric or focus for what I have indicated as some of the key factors of one's personal experience. If we can expect that the present scientific procedures will explain our total world satisfactorily, we may well rest content with the concept of a universe that lies within the scope of science. But there are in fact noncognitive elements in our awareness which we can expect to remain outside the scope of science, whatever the continued growth of science.[14] A science always rests on assumptions, tacit and otherwise. (The very presumption that it is desirable to strive for truthful description and theory is one of them.) The total interaction of each person with the universe—much of it on a subconscious level—brings to him or her, among other things, the content that I have associated above with experience of the divine or God-like element in the world.[15] In applying the term "God" we have a category whereby this content from our

own experience and from the communicated insights of others can be associated with root questions of guidance and meaning in life.

If the divine postulate is accepted, we shall find that the relatively firm and defined assertions of science place constraints upon our conceptions of God. Obviously there is a converse contribution too. Science, as well as any other part of human activity, can have meaning and value for a person only through his ultimate attitudes and beliefs. And yet I suppose it would be rash to say that God is certainly or is certainly not a useful word, that is, to assert that there is or is not a divine warrant for one's central beliefs about value and action. Most of us, I assume, would hope that there is at least to some degree such a harmony between our first convictions and the nature of the universe. But again it can be objected that one adds nothing by use of "divine," particularly since if we accept the divine postulate we intend by that word too a reference to "what exists," using that phrase with the same intention as in natural science. In my judgment, however, if one finds first principles of meaning and behavior to be part of a reaching for what is best in the universe, one may see them justifiably as associated with God, considering the overall tradition of use for that word. The subjective definition that we make for God is then an element in whether we find a divine aspect for the universe.

NOTES

1. Karl E. Peters, "The Image of God as A Model for Humanization," *Zygon* 9 (June 1974): 112.

2. Ibid., pp. 112-13.

3. This point of view has been eloquently argued by Alfred North Whitehead. In *Science and the Modern World* (New York: Macmillan Co., 1931), p. 19, he writes: "... the faith in the possibility of science, generated antecedently to the development of modern scientific theory, is an unconscious derivative from medieval theology."

4. Charles Hartshorne and William L. Reese, *Philosophers Speak of God* (Chicago: University of Chicago Press, 1953), pp. 15-25.

5. Ibid., p. 351.

6. Ibid., pp. 395-408.

7. Richard Schlegel, "Quantum Physics and Human Purpose," *Zygon* 8 (September-December 1973): 200-20.

8. Hugo Adam Bedau, "Complementarity and the Relation between Science and Religion," *Zygon* 9 (September 1974): 202-24; D. M. MacKay, "Complementarity in Scientific and Theological Thinking," ibid., pp. 225-44.

9. Werner Heisenberg, *The Physicist's Conception of Nature*, trans. A. J. Pomerans (New York: Harcourt, Brace & Co., 1958), p. 29.

10. George A. Riggan, "Epilogue to the Symposium on Science and Human Purpose," *Zygon* 8 (September-December 1973): 474. I thank Riggan for explicating his views in private correspondence.

11. See *The Many-Worlds Interpretation of Quantum Mechanics*, ed. B. S. DeWitt and Neill Graham (Princeton, N.J.: Princeton University Press, 1973). A semipopular account has been given in a paper by B. S. DeWitt, "Quantum Mechanics and Reality," in ibid.

12. William James, *The Varieties of Religious Experience* (New York: Modern Library, 1902).

13. Alfred North Whitehead, *Process and Reality* (New York: Macmillan Co., 1929), esp. p. 526: God is "the poet of the world, with tender patience leading it by his vision of truth, beauty, and goodness."

14. I discussed the limits of science in detail in *Completeness in Science* (New York: Appleton-Century-Crofts, 1967).

15. Michael Polyani forcefully stated the role of nonconceptual learning even in science. See his *Personal Knowledge* (London: Routledge & Kegan Paul, 1958).