METAPHYSICS AND EPISTEMOLOGY IN STEPHEN HAWKING'S THEORY OF THE CREATION OF THE UNIVERSE

by Joseph M. Życiński

Abstract. In 1981 S. W. Hawking and J. Hartle presented a quantum mechanical description of the early stages of possible cosmological evolution. Their proposal was interpreted by many authors as a pattern of cosmic creation from nothing in which no divine Creator is needed. In this approach, physically defined "nothing" was identified both with the empty set of set theory and with metaphysical nothingness. After defining philosophical presuppositions implicitly assumed in Hawking's paper, one discovers that this alleged nothingness has all properties of the philosophically conceived Logos accepted by Hellenic philosophers of the Neoplatonic tradition. Consequently, Hawking's theory of creation remains consistent with Christian theism, and its only theological opponents can be found among defenders of Samuel Clark's God of scientific gaps.

Keywords: being; boundary conditions; cosmological models; creation; instrumentalism; logos; nothingness; physical vacuum; quantum cosmology; quantum mechanics; scientific realism; singularity; theism; time.

---

1. The Problem of the Beginning of Time in Relativistic Cosmology

In 1922 the Russian physicist A. A. Friedman, in his paper on Einstein's general theory of relativity, provided a mathematical description of the initial stage of cosmic evolution. In this description, strange physical parameters appeared, since at the moment t_0 the universe's radius R was equal to zero while the parameter for the density of matter assumed an infinite value. If in the Friedman model the density

Joseph M. Życiński is Professor of Philosophy of Science in the Faculty of Philosophy at the Pontifical Academy of Theology, Craców, Poland. He is also Bishop of Tarnów, Moscickiego 9, 33 100 Tarnów, Poland. This paper was presented at the annual Cosmos and Creation Conference at Loyola College in Maryland, Baltimore, 26–28 May 1995.

[*Zygon*, vol. 31, no. 2 (June 1996).]
 ISSN 0591-2385

parameter assumes an infinite value, we say that a singularity occurs. These physical properties corresponding to the moment t_0 seemed so strange to Friedman himself that he decided to call the bizarre initial state of the cosmic evolution "the state of the creation of the world." The very expression caused many troubles to Soviet ideological commentators on Friedman, who had to argue that the term expressed only the sense of humor of its author.

For a long time, the prevailing opinion in cosmology was that the singular state in Friedman's solution resulted from simplified assumptions concerning the distribution of matter in cosmic space. Einstein himself suggested that if the assumptions were more realistic, the singular points would not appear in cosmological models and the problem of the creation of the world would be devoid of any scientific basis. Contrary to such a view, in the late 1960s, S. W. Hawking, R. Penrose, and R. Geroch proved that the appearance of singularities in cosmological models does not depend on simplifying assumptions but results from suppositions that seem both straightforward and realistic.

On a philosophical level the discussions about the initial singularity inspired the standpoint sometimes called "singularity mysticism." Its adherents referred to God the Creator to explain the breakdown of the laws of nature and principles of modern physics at singular points of cosmological models. In those explanatory proposals, one finds a new version of the Clarkean physico-theology in which the God of scientific gaps invented by Samuel Clarke in his eighteenth-century polemics with Leibniz is replaced by the God of cosmological edges. In this new approach, God the Creator appears when the natural sciences reach a boundary in their explanatory procedures, in the well-known manner characteristic of the deus ex machina. As the history of science reveals, new scientific discoveries tend to bridge such gaps without reference to any supernatural Agent. This experience results in criticism of new attempts to reduce the Divine Creator to the role of a cosmic edge that determines the initial distribution of physical objects.

Another problem is that such reduction easily may be inconsistent with the Christian doctrine of divine immanence in nature. According to this doctrine, God is hidden neither in scientific gaps nor behind cosmological edges, but rather is the Lord of all nature, who permeates and continuously governs the created world and in whom "we live, we move and have our being" (Acts 17 : 28). God's presence can be discovered both in the cosmic order, subordinate to physical laws, and in the breaking down of certain laws near the singular stage in cosmic evolution. The process of creation cannot, therefore, be limited to singular events in the Planck era because "God is *semper Creator*. . . . God is creating now and continuously in and through the inherent, inbuilt

creativity of the natural order, both physical and biological—creativity that is itself God in the process of creating" (Peacocke 1986, 95).

Neither philosophical antipathy to the God of scientific gaps nor possible theological predilection for the God of cosmological edges can substantiate any answer to the question whether the Friedmanian moment t_0 constitutes the absolute beginning in the physical evolution of the universe. There are no physical or philosophical means that would make it possible to prove that at this very moment our universe emerged from ontologically understood nothingness. The methodological principles of modern physics imply that any physical state S_n should be explained by reference to an earlier state S_{n-1}. For methodological reasons, the scientific series of explanations in the past of the universe should be continued ad infinitum unless one proves that the moment t_0 must be introduced into cosmic history as an "absolute zero," much as the absolute zero of temperature must be accepted in Kelvin's scale. This methodological principle, basic for scientific explanation, could be abandoned if, and only if, substantiated physical arguments in adopted scientific theory would justify the thesis that a well-defined physical state should be regarded as the absolute beginning of the universe.

In his quantum model of creation, Hawking provides a very interesting explanatory device in which the moment t_0 is eliminated thanks to the introduction of imaginary (in the sense of complex numbers) temporal coordinates. His proposed explanations, besides being interesting mathematical tricks, contain important epistemological and metaphysical assumptions that must be taken into consideration in the appraisal of various stages in Hawking's philosophy of creation.

2. The Evolution of Hawking's Views of Cosmic Creation

In presenting the growth of Hawking's understanding of cosmic creation, one has to take into consideration at least three versions of his explanatory proposals. They are contained in (1) the paper written with J. B. Hartle on the wave function of the universe (Hartle and Hawking 1983), (2) the best-seller *A Brief History of Time* (Hawking 1988), and (3) Hawking's recent writings, which provide the most critical and the most mature version of his philosophy of creation.

Before the well-known paper by Hawking and Hartle was published, E. P. Tryon (1973) and R. Brout, F. Englert, and E. Gunzig (1978) described the process of creation within the framework of preexisting space-time. Strictly speaking, one could not address *creatio ex nihilo* in this manner, since the newly created particles emerged from the curvature of space-time. Then, in a radical appraisal of the role of these new

theories, John Gribbin argued that the new physics of creation leaves no place for the traditional metaphysics of creation because new cosmological models ultimately explain how the universe *created itself*, emerging from nothing at a certain moment t_0; as a result, he said, the metaphysicians "are out of a job" (Gribbin 1986, 392).

An opposite view was defended by C. J. Isham, who contended that many intriguing problems related to creation and evolution of the universe cannot be explained in the cognitive framework of modern theoretical physics. Consequently, one must look for explanations that do not belong to the physical sciences (Isham 1988, 405). I share the latter opinion, and I think that various metaphysical theories can be based on any physical theory of cosmic creation. By determining which philosophical principles are implicitly assumed in the creation models accepted in the theory of vacuum fluctuations, we can better understand which important philosophical presuppositions are tacitly implied by these models. The analysis of these principles demonstrates both the fuzziness of many philosophical concepts and the illusionary character of the methodological standpoint in which the physics of creation was supposed to eliminate traditional metaphysics. In fact, metaphysics is either implicitly accepted in new physical theories or explicitly introduced in a naive commonsense version.

In traditional metaphysics, the fundamental concept of nonbeing was defined in such a vague manner that many authors did not distinguish between metaphysical nothingness and physical vacuum. A vacuum in quantum electrodynamics is understood as the lowest energy state of a field in which no physical particles exist. To argue against the identification of the vacuum with philosophically conceived nothingness, one may claim that the vacuum possesses a rich mathematical structure that can be described by means of the formalism of quantum field theory. The absence of physical particles in the vacuum can be described in this formalism by the formula $\hat{a}\psi_0 = 0$, where $\hat{a}$ is an annihilation operator and ψ is the state vector. Despite the absence of particles, physical fields do not disappear, and their properties still can be characterized in the abstract language of mathematics. The state vector ψ characterizing an arrangement of n particles in states i = 1, 2, . . . , n can be presented as the result of the action of n creation operators on the state vector of the vacuum. Designating these operators by $\hat{a}_i$, we can describe any physical state of the investigated system as a function of the state vector of the vacuum: $\psi = \hat{a}_1, \hat{a}_2, \ldots, \hat{a}_n \psi_0$.

The indicated possibility indicates that in an evolving physical system, any particular state described by the vector ψ can be regarded as the actualization of potentialities that are contained in the physical vacuum. From a philosophical point of view, this vacuum may be

conceived as a unique field of potentialities of which only some possibilities are exemplified (instantiated) in the physical processes that occur at the present stage of cosmic evolution.

New physical theories of creation contribute to a better understanding of classical distinctions between the actual and the possible on the one hand and being and nothingness on the other. First, one has to notice that the "nothingness" in these theories possesses rich mathematical structure. It can be described in the language of mathematics. Consequently, its status seems similar to that of a philosophical logos, as understood in the Heraclitean or the Neoplatonic tradition, rather than to that of nonbeing. Second, to avoid conceptual chaos one must grant real existence not only to actual but also to possible objects. Such a decision requires ontological commitment in which abstract possibilities are regarded as constituents of the primordial ontic level and their concrete exemplifications constitute the subsequent observable reality of everyday experience.

Regardless of this ontological commitment, the physicists who rightly contend that four-dimensional empty space cannot be regarded as a counterpart of metaphysical nothingness have undertaken more ambitious attempts to construct new physical models of the creation *ex nihilo*. A solution very interesting from a philosophical point of view can be found in proposals worked out by Alex Vilenkin (1986). In his approach, proposed in 1983 in a paper *The Birth of Inflationary Universes*, there is no preexisting space. The creation of space-time results from a quantum-mechanical effect that can be described in terms of so-called tunneling. Before this effect occurs, there are no physical particles, no matter, no space, no time; using the language of mathematics one could compare this state with the empty set of the set theory.

Can we identify the mathematical concept of the empty set with metaphysical nonbeing? C. J. Isham, when describing the philosophical significance of the tricky solution proposed by Hartle and Hawking, admits that this form of creation can be regarded as a creation from empty space. In his opinion: "The initial space from which the universe 'emerged' can be defined to be that part of the boundary of the four-dimensional space which is *not* part of the (later) three-surface. But this is the empty set, which gives a precise mathematical definition of the concept of 'nothing'!" (Isham 1988, 396, 401).

Can the empty set really be regarded as a counterpart of the metaphysical concept of nothing? One has to notice that mathematically understood "emptiness," in the Hawking-Hartle proposal, is subject to the laws of quantum cosmology as well as to basic principles of logic. These principles and laws are valid even when no physical structures exist. Their validity defines the domain of the *possible evolution of the universe*. Regardless of the methodological conventions, there remains

the very fact that we can describe mathematically the mechanism of emergence of the existing cosmic structures from the state of physical "nothingness" in which only abstract mathematical-logical principles may be thought of as real. Can these flaws in Vilenkin's model be overcome in Hawking's explanatory schemes?

Certain defects of Vilenkin's proposals were avoided in the quantum-mechanical description of the early universe that was proposed by Hartle and Hawking. The important accomplishment of this new approach was that the authors did not assume any space-time framework and did not introduce the traditional distinction between boundary conditions and the equations of motion. In this cosmology without initial conditions, a single unique state-function is defined to determine probabilistically the entire evolution of the quantum universe. The model, dependent on particular physical assumptions, implies sets of physical data that can be empirically tested. Its explanatory value, combined with conceptual tricks, introduces an attractive explanatory framework and provides the possibility of avoiding many confused traditional questions. Substantively, the Hawking-Hartle model has two important merits in the domain of classical philosophical issues:

1. It removes the problem of the beginning of time by an adroit procedure in which no initial singularity appears in the edgeless compact space-time. There is no breakdown of physical laws in the initial stage of cosmic evolution. In this model, past infinity is avoided because time ceases to be well defined in the early cosmic stages. However, "to ask what happened before the universe began is like asking for a point on Earth at 91° north latitude; it just is not defined" (Hawking 1987, 651). Accordingly, the so-called beginning of time loses its importance as a feature of cosmic history.

2. As a result of eliminating the singularity gap at the moment t_0, the model eliminates also the need for the deistically conceived Creator who was supposed to bridge the singularity gap. As Willem B. Drees commented, "the removal of a beginning would imply that the watchmaker God is not a defendable image" (Drees *1990, 71*). Both Hawking in his publications of the period 1981–88 and Sagan in his introduction to *A Brief History of Time* identified the Clarkean God of physical gaps with the God of Christian theism. In their arguments, cosmological edgelessness implies metaphysical denial of the existence of God. Similar identifications, already assessed critically by Leibniz in his polemics with Clarke, are revoked as groundless by Hawking in 1993 in his *Black Holes and Baby Universes and Other Essays*. Not only did physical models of creation evolve in Hawking's scholarly contributions, but his metaphysics and theology became more mature as well.

3. Epistemological Presuppositions in Creation Models

To assess objectively the value of the theory of creation from nothing, as recently developed by Hawking, one must answer the question whether the very notion of nothing can be meaningfully accepted in these theories. According to Adolf Gruenbaum, all quantum descriptions of the emergence of energy of the so-called "nothing" imply creation *ex nihilo* "only in a rather Pickwickian sense" (Gruenbaum 1990, 110). Accordingly, he suggests adopting the terms *matter-increase* or *accretion of matter* to describe the process of particle creation in the classical version of the steady-state theory proposed by Bondi, Gold, and Hoyle. Though I do not share the terminological preferences of Gruenbaum, I do agree that in none of the models of creation proposed by Hawking can we find a counterpart of the metaphysically conceived *creatio ex nihilo*. This objection does not stem from epistemological differences between metaphysics and quantum cosmology. Such differences would be obvious and natural. The basic problem remains, however, that in none of Hawking's models is the very notion of nothing (*nihilum*) accepted in the sense in which it was classically understood in a metaphysical description of *creatio ex nihilo*. *When "nothing" denotes "something," the so called "creation," in a physical sense of this term, can denote anything.* This very problem requires more exhaustive analysis in the domain of epistemology and metaphysics.

All Hawking's proposals in the domain of physics have important ramifications in epistemology, metaphysics, and theology. Hawking himself initially did not distinguish these four cognitive levels. Consequently, he claimed that his physics of creation made useless the traditional interpretations worked out earlier in philosophy and theology. In his version of cognitive monism, Hawking argues that evolving scientific theories allow us to eliminate from human knowledge both the notion of mystery and the notion of God (cf. Weber 1986, 212). Accordingly, after presenting his model of creation out of nothing during a Vatican conference in 1981, he was seriously disappointed that in a later speech John Paul II dared to mention God the Creator. Hawking's belief that physical theories can eliminate the need for both metaphysics and theology was consistently extended into the domain of his existential attitudes. His former wife, Jane Wade, in one of her interviews, stressed the point that her important role in their everyday family situation required her to make Stephen aware that he really is not God (cf. White and Gribbin 1992, ch. 16). In Hawking's epistemological attitude of this period one can find simplistic tenets of early logical positivism. The belief in one rational interpretation of the world that eliminates any sense of mystery, the belief that science can answer all

ultimate questions of humankind, the conviction that physics can provide explanations that would be at the same time consistent and complete—all recall outdated principles of the philosophy of science developed in the early 1920s. When he had to search for simple answers to complicated questions of theoretical physics, Hawking professed a form of cognitive monism in which he adopted the simplest epistemological principles to make privileged the explanatory proposals provided by him. Being fascinated by the effectiveness of the mathematical description of the world, he argued that comments on the mystery of nature are developed mainly by those authors who do not understand mathematics (cf. Hawking's dialogue with Weber in Weber 1986, 210).

In the context of this existential experience, one can excuse Hawking's naive philosophy ascribed to his physical models. It is, however, much more difficult to excuse those authors who uncritically followed Hawking's naive remarks in their explanations that were supposed to provide substantive analysis of such fundamental issues as the relationship between the theological and physical interpretation of nature. An example of this attitude can be found in Michael White and John Gribbin's best-seller, *Stephen Hawking: A Life in Science*. When describing Hawking's meeting with John Paul II in 1982, the authors inform us that his quantum theory of creation was contrary to the orthodox doctrine of the church and that his views were inconsistent with the church's teaching about the creation *ex nihilo* (White and Gribbin 1992, ch. 16).

4. The Metaphysical Presuppositions of Physical Creation

The obvious achievement of the Hawking-Hartle model is the avoidance of the question of physical parameters that describe the initial state S_{i-1} necessary to determine the subsequent state S_i. In his search for a physical theory of cosmic evolution, Hawking looks for both the most fundamental laws of nature and the ultimate boundary conditions of the universe. After assuming the famous axiom that "the boundary condition for the Universe is that it has no boundary," Hawking regards a state S_i as the only boundary and calculates its probability on the basis of general principles of quantum theory. Many authors argue that the emergence of the universe in the initial state S_i can be regarded as creation from nothing since "the Universe [seems] to appear from Nothing" (Hartle and Hawking 1983, 2961) because there was no other physical state prior to S_i. The temporal notion of priority, defined in terms of the absence of the space-temporal edge, does not imply, however, the metaphysical notion of absolute nothingness.

Is there a notion of nothing, in the classical sense of traditional metaphysics and theology, underlying any paper by Hawking? My answer is negative, since it is easy to demonstrate that the alleged nothing of Hawking's cosmological models implies the existence of physical principles and logical-mathematical structures that from the metaphysical point of view can never be regarded as nothing. Only on the physical level may such identification seem acceptable, either because certain observation parameters assume zero values or because tacitly accepted presuppositions of theoretical physics go unnoticed since they seem obvious. The psychologically conditioned notion of obviousness does not justify, however, reducing to nothing principles and conditions that are far from trivial from a metaphysical point of view.

What kind of physical or nonphysical entities are implicitly assumed as necessary conditions in the quantum process of the emergence of the edgeless universe? At least four types seem to be involved:

1. The validity of a set of the laws of nature is assumed before the construction of the model. Were the reality orderless and chaotic in the traditional sense of the latter term, there would be no reason to apply field equations and the laws of quantum cosmology to the boundary state S_i.

2. Mathematical principles dealing with probabilistic distribution are accepted in the description of the no-boundary state. Mathematical definitions dealing with the topological concept of compactness and the number-theoretic concept of imaginary coordinates are necessary to describe the earlier stages of cosmic evolution. Their use implies references to another set of sophisticated mathematical structures that must be assumed to make possible the construction of the model.

3. Logical principles allowing deductive reasoning in the construction of the model are far from trivial. Cosmological prehistory of the universe could have been essentially different if the logic of dreams, with Feyerabend's famous principle "anything goes," governed in the early stages of the cosmic evolution. However, imposing on these stages the well-known principles of classical logic implies important restrictions on the level of physical processes. For the philosopher, these principles seem ontically prior to the emerging physical objects. Consequently, a puzzling reality of a cosmic logos seems anterior to any physical process; we may argue that these processes originate in the cosmic logos. What was too easily identified with metaphysical nothingness seems to be a sophisticated reality of the logos, described by Hellenic philosophers of the Neoplatonic tradition. Contemporarily, a version of Neoplatonic logos, understood as the creative and ordering principle, is developed by John Leslie in the context of anthropic principles and cosmological theories of creation (Leslie 1989, 167–174).

One cannot justify simple declarations of the creation of the universe out of logos because mathematical-logical structures are not transformed into a physical substratum. The significance of these structures for the creation process cannot, however, be ignored because they are real in a different manner than the physical objects given in everyday experience.

One could have tried to defend a reinterpreted version of the Hawking-Hartle model, arguing that we do not need any preexistent principles, physical or mathematical, before the emergence of the universe in the boundary state S_i. Only after this emergence are there the laws of physics and principles of logic that we know; these remain valid for the evolving universe. If such were the case, one could not eliminate the possibility that before the boundary state S_i there existed different universes with laws different from our laws of nature, different principles of mathematics, etc. Such universes could have been submitted to laws of physics unknown to our science. Their evolution could have been developed, for instance, according to the logic of our dreams, while an edgeless "initial" boundary state would be just a state that happened from time to time in the discontinuous process of cosmic growth. Unless Hawking accepted the preliminary validity of the principles mentioned in (1), (2), and (3), he could not have proven that his model describes the earliest stage of the cosmic evolution and must not be anteceded by other models describing earlier stages subject to different physical-mathematical principles. The preexistence of a cosmic logos thus seems necessary to prove that the state S_0 can be regarded as the boundary state not preceded by any other physical phenomena.

4. The Hawking-Hartle model in its original version also implies methodological presuppositions. They deal, for instance, with the so-called normalization procedure. To determine the wave function of the universe, the authors assume that there is a probability equal to 1 of having a metric at a three-dimensional spacelike surface. This procedure requires at least two methodological assumptions: (1) Analogies from quantum physics can be used at a cosmological level to describe the universe, which has been *ex definitione* the only and unique object in its class; (2) the normalization of the wave function of quantum objects requires that the integral of the probabilities over the whole space must yield probability equal to 1 at any moment t. In such normalization practice, the very assumption that the outcome is set to 1 tacitly introduces the thesis that the universe exists.

This very procedure implies many awkward problems (cf. letter from Isham to Drees in Drees 1990, 275). Certainly, if theoretical physics should produce a new technique in normalization procedures, it might also lead to a methodology different from the one presupposed in the

Hawking-Hartle model. In such a new methodology, however, certain assumptions still will be required to solve the metaphysically important problems (although in Hawking's proposals they were implicitly accepted as self-evident). Such a possibility sheds new light on the nature of the logos mentioned above. We can define its nature in the language of relationships determining both cosmic evolution and its scientific study. In this class of relationships one may distinguish a proper subset of relations that are instantiated in physical processes as well as in actual scientific procedures. Twenty billion years ago, in the early stages of cosmic evolution, no law of the evolution of galaxies was instantiated, since no galaxies existed in that epoch. In the research practice of medieval physics, no normalization procedure existed because the reality of the microworld was unknown at that period. Consistently, we are entitled to claim that the initial logos, containing all scientific principles and physical laws, is only partially instantiated in today's known cosmic structures and in the process of scientific growth. Its reality is disclosed in the observed physical phenomena through their conformity to the principles of theoretical physics and through the effectiveness of this physics in predicting new facts. These important characteristics of physical structures of the world make groundless declarations about the physical models of the creation of the universe out of nothing. The alleged nothing turns out to be a complex reality of ordering principles without which there would be no uniformity in nature and no scientific study of natural phenomena would be possible.

5. Time and Creation in *A Brief History of Time*

Physical ideas underlying Hawking and Hartle's paper are supplied with extended philosophical comments in *A Brief History of Time*. This best-seller should have been called rather "A Brief History of Modern Physics," for only in chapter 9 does it deal with time. The other ten chapters deal with the development of physical ideas about the universe from Copernicus to string theories. The author's concern with philosophical and theological issues makes the book interesting even for readers who need not be told anew about the uncertainty principle or special relativity theory. The content of the work was directed to the general reader. Since the writing of his "quite unreadable" *The Large Scale Structure of Space-Time*, says Hawking, he has learned a lot about how to write in an understandable manner (Hawking 1988, vi). He does not use mathematical equations beyond the famous $E = mc^2$ because, he was told, each equation "would halve the sales." Thus, instead of using such exponential notation as "10^{66}" he speaks of "1 with 66 zeros after it" (p. 108).

This road to salability led him to oversimplify details not only in

mathematics, which could be justified, but also in other matters, making the work often historically inaccurate and philosophically naive. Sharing the cognitive optimism of early positivism, Hawking asserts repeatedly that current physics may be "near the end of the search for the ultimate laws of nature" (p. 156). In this celebration of the cognitive successes of physics, in which science explains everything, the role of philosophy is to be reduced to the analysis of language (p. 175). Hawking cites Wittgenstein to justify this opinion and calls him "the most famous philosopher of this century" (p. 175). In fact, Wittgenstein, in the late period during which he wrote *Philosophical Investigations*, revised his earlier stand and declared that philosophy cannot be reduced to the analysis of language.

Similar side remarks disclose Hawking's level of philosophical competence; they do not affect, however, the essence of his philosophy of creation. In the context of his earlier explanations dealing with the beginning of time and the special role of imaginary coordinates in describing the cosmic evolution, there arises the important question, Does Hawking's cosmology underlie epistemological realism? Several statements in the book suggest that the author rejects scientific (epistemological) realism in favor of epistemological instrumentalism. For instance, he describes as "meaningless" the question, Does the time of our physical experience correspond to the real or the imaginary coordinates of the space-time representation of relativity theory? He argues that scientific theories do not describe reality but are merely useful mathematical models which describe regularities that exist "only in our minds" (p. 139). After such a strong declaration, one is amazed to read two pages later that physical cosmology is so successful in "describing events" and cosmic laws that in its picture of the completely self-contained universe without boundaries there is no place either for a Creator or for theological explanations (p. 140f.). If scientific theories describe solely the reality existing "only in our minds," then the absence of God in a given explanatory scheme indicates merely that God was absent from the mind of the author of the theories.

On the level of interpretations characteristic of natural sciences such an absence has been methodologically justified, since natural sciences can explain natural phenomena only by reference to another set of natural phenomena. This methodology already was obvious for Galileo when he argued that natural human reasoning should be used to solve controversial astronomical issues, while the reverence given to the Bible should be expressed in applying its content only to theological problems (Galileo 1890, 7:385). Though he never denied the value of theological explanations, Galileo contended in the *Dialogo* that, for methodological reasons, these explanations must be excluded from the

domain of astronomical research. Otherwise, one could always refer to angels or miracles to explain given empirical data, and as a result astronomy would remain merely a branch of applied angelology (Galileo 1890, 7:263, 7:325, 5:316).

What seemed methodologically self-evident for Galileo in the seventeenth century seems a breakthrough discovery three centuries later for Carl Sagan. Thus, in his introduction to Hawking's book, Sagan maintains that the absence of God in the universe is the principal topic of *A Brief History*. He sums up his position by saying that in this universe there is "no edge in space, no beginning or end in time, and nothing for a Creator to do" (Hawking 1988, x), a statement quoted in many reviews. Drawing such a conclusion from the book is a bit hasty, considering at least Hawking's remark that his idea of an edgeless universe is not a conclusion but a proposal that cannot be deduced from more-fundamental principles (136). Certainly, one can dogmatically adhere to this idea, accepting it as an article of faith. There are, however, alternative cosmological proposals developed in Penrose's twistor program or in Linde's "chaotic cosmology." Criteria of selection should depend on the explanatory content of particular models in the domain of quantum cosmology, not on the metaphysical preferences of their authors.

Hawking's metaphysical and theological views demonstrated in the *Brief History of Time* seem to be as simple as his mathematical notations. He repeats trivial cliches of Scholastic theology when he asks how heavy stones can be created by God and does not avoid the question, By whom was God himself created? (p. 174). To Hawking's presentation of a God of the edge, who is imagined to counteract the limitations of scientific theories, one may apply Leibniz's eighteenth-century comments, in which he criticized Clarke for introducing the hypothesis of God to fill the gaps in physical theories. The difference between Hawking and Leibniz is that in the present intellectual climate practically no theologian defends the theological views of Clarke, the views that are so strongly and extensively criticized by Hawking. Contemporary polemics with Clarke would look like a new form of criticism of Ptolemy's astronomy. They could be right but not particularly inventive.

6. Creatio Continua

In his BBC interview by Sue Lawley in December 1992, Hawking moderated many of his earlier philosophical comments concerning his no-boundary model of creation. Eliminating the naive Clarkean theology, he admitted that the model itself justifies no conclusion regarding the existence or the nonexistence of God. It only illustrates that the possible creative act of God was not arbitrary in nature but depended on laws and principles known to theoretical physics (Hawking 1993,

chap. 14). He specifies neither what kind of dependence is involved here nor whether the principles in question are results of the creative act of God. His personal philosophy remains open to this question. Consequently one should not ascribe to Hawking's model a restrictive philosophical significance that he himself did not intend. The accent put on the rational character of the process of creation, which should not be understood as a capricious violation of the laws of nature, may seem trivial because there are few authors who, like Bertrand Russell, would entertain a whimsical creation independent of any deterministic interpretation. One has to remember, however, that most of the Marxist authors, in their critique of the possibility of cosmic creation, quoted F. Engels's argument that such an act of creation is scientifically illegitimate because it violates basic laws of nature, including the conservation of energy. Hawking's cosmological contribution reveals the groundlessness of similar opinions.

Hawking stressed another important point in the same 1992 interview. He pointed out that a physical description of the appearance of the no-boundary universe does not explain why the universe does exist in any particular moment of cosmic time. In this profound remark we can find an echo of Leibniz's question, Why is there anything rather than nothing? Both questions are metaphysical in nature because physics itself does not raise such questions and never asks, e.g., why laws of nature exist when nature itself could have been an uncoordinated disorder in which no regularities could have been determined. Physics presupposes the uniformity of nature, and this presupposition constitutes a *conditio sine qua non* for the existence of physics in its present form. Had the universe evolved in a discontinuous manner, so that either physical laws or physical particles might unpredictably disappear, there would be no science in the present meaning of this term. One could at most develop a local counterpart of science–between succeeding discontinuities. Continuity in the existence of the laws as well as physical objects remains a metaphysically nontrivial property of the universe that has attracted the attention of many philosophers (Davies 1992, 69).

It is important that Hawking himself highlights the cognitive significance of this property. His remark remains consistent with the important intellectual tradition that defined the status of creation in terms of dependence of the created object on its Creator. It was Thomas Aquinas who wrote in *Summa theologica* I a. q. 45. art. 3 (c), "Creation is none other than the relation of the creature to the creator as to the principle of its very being." This very relation remains independent of time; in the Christian intellectual tradition it was described either as *creatio continua* or *creatio passiva.* In Pierre Teilhard de Chardin's terminology it would be called "evolutive creation"–*création evolutive.*

Hawking's final version of creation would certainly be attractive for Christian representatives of the process philosophy inspired by A. N. Whitehead's metaphysics. It points to a process in which the traditional basic question of the absolute beginning would be either pointless or dependent on conceptual convention. In this approach a Clarkean God of edges is replaced by an immanent God sustaining his creation in all moments of time. He remains also transcendent to the created world in the sense that, as the Creator he remains the fount of being for all creation. Such a vision is suggestively illustrated by C. J. Isham when he writes of "the universe . . . being held in the cup of God's hand" (Isham 1988, 405).

Whether to blame Isham's analogy for its anthropomorphism or to exalt its biblical resemblance remains a question of personal preference. The analysis provided above points out that there is no substantive conflict between Hawking's no-boundary model of creation and the traditional Christian doctrine of creation. Preliminary opinions about such a conflict resulted from a naive theology in which Samuel Clarke was supposed to be the most brilliant exponent of the Christian teaching on creation.

It is worthy of note that in his interview of 1992 Hawking emphasized that there are important domains of human experience that cannot be reduced to a physical level. He mentions love, faith, and morals as three examples of experience that cannot be explained by reference to the laws of physics. This statement reveals that in Hawking's recent work we no longer find the epistemological monism that inspired his works when he thought that theology could be replaced by physics. Such epistemological declarations can be justified only when one acknowledges that on the ontological level there exists reality irreducible to physical elements. We find no such explicit declaration in Hawking. We can, however, summarize his philosophical evolution by saying that his earlier proposals were simple and nonchalant, while his later modifications are much more balanced and closer to the classical tradition in philosophy.

One should not expect that Hawking's cosmology would provide a new argument for the existence of God the Creator and strengthen the standpoint of Christian theism. Skeptics would always be inclined to ask, like Adolf Gruenbaum (1990, 111), whether divine attributes must be ascribed to any agent involved in a physically described process of creation. What "divine attributes" does mean remains a separate complex problem. We certainly cannot prove that the creating agent is a person, as is centrally important for Christian theism. Nonetheless, it is also important to overcome antitheistic arguments shared by early Hawking and Gribbin and their numerous adherents.

REFERENCES

Brout, R., F. Englert, and E. Gunzig. 1978. "The Creation of the Universe as a Quantum Phenomenon." *Annals of Physics* 115 : 78–106.

Davies, P. 1992. *The Mind of God: The Scientific Basis for a Rational World.* New York: Simon and Schuster.

Drees, W. B. 1990. *Beyond the Big Bang: Quantum Cosmologies and God.* LaSalle, Ill.: Open Court.

Galileo Galilei. 1890. *Le Opere di Galileo Galilei*, ed. A. Favaro. Florence: G. Barbera.

Gribbin, J. 1986. *In Search of the Big Bang: Quantum Physics and Cosmology.* New York: Bantam.

Gruenbaum, A. 1990. "The Pseudo-problem of Creation in Physical Cosmology." In *Physical Cosmology and Philosophy*, ed. J. Leslie. New York: Macmillan.

Hartle, J. B., and S. W. Hawking. 1983. "Wave Function of the Universe." *Physical Review D* 28 : 2960–75.

Hawking, S. W. 1987. "Quantum Cosmology." In *Three Hundred Years of Gravitation*, ed. S. W. Hawking and W. Israel. Cambridge: Cambridge Univ. Press.

_____. 1988. *A Brief History of Time: From the Big Bang to Black Holes.* New York: Bantam.

_____. 1993. *Black Holes and Baby Universes and Other Essays.* New York: Bantam.

Isham, C. J. 1988. "Creation of the Universe as a Quantum Process." In *Physics, Philosophy and Theology*, ed. R. Russell et al. Vatican City State: Vatican Observatory.

Leslie, J. 1989. *Universes.* London: Routledge.

Peacocke, A. 1986. *God and the New Biology.* San Francisco: Harper and Row.

Tryon, E. P. 1973. "Is the Universe a Vacuum Fluctuation?" *Nature* 246 : 396–97.

Vilenkin, A. 1983. "The Birth of Inflationary Universes." *Physical Review D* 27 : 2848–55.

_____. 1986. "Boundary Conditions in Quantum Cosmology." *Physical Review D* 33 : 3560–69.

Weber, R. 1986. *Dialogues with Scientists and Sages: The Search for Unity.* London: Routledge.

White, M., and J. Gribbin. 1992. *Stephen Hawking: A Life in Science.* London: Viking.