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ATHEISM, THEISM AND BIG BANG COSMOLOGY

Quentin Smith

I. Introduction

The idea that the big bang theory allows us to infer that the universe began to exist about 15 billion years ago has attracted the attention of many theists. This theory seemed to confirm or at least lend support to the theological doctrine of creation *ex nihilo*. Indeed, the suggestion of a divine creation seemed so compelling that the notion that 'God created the big bang' has taken a hold on popular consciousness and become a staple in the theistic component of 'educated common sense'. By contrast, the response of atheists and agnostics to this development has been comparatively lame. Whereas the theistic interpretation of the big bang has received both popular endorsement and serious philosophical defence (most notably by William Lane Craig and John Leslie[1]), the nontheistic interpretation remains largely undeveloped and unpromulgated. The task of this article is to fill this lacuna and develop a nontheistic interpretation of the big bang. I shall argue that the nontheistic interpretation is not merely an alternative candidate to the theistic interpretation, but is better justified than the theistic interpretation. In fact, I will argue for the strong claim that big bang cosmology is actually *inconsistent* with theism.

The cosmological theory that has been endowed with the theistic interpretation is the *classic big bang theory* (also known as 'the standard hot big bang theory'), which is based on the Friedmann models with their prediction of an original big bang singularity. In this paper I shall also work with this theory, as supplemented (as is now standard practice) with the singularity theorems and Hawking's principle of ignorance. But we must be careful about how we view the significance of this classical theory. We cannot say that it is 'the final truth' about the universe, since it is thought by many cosmologists that this classical theory will one day be replaced

[1] *Vide*, William Lane Craig, *The Kalam Cosmological Argument* (New York: Harper and Row, 1979); 'God, Creation and Mr Davies', *British Journal for the Philosophy of Science* 37 (1986) 163-175; 'Barrow and Tipler on the Anthropic Principle vs. Divine Design', *British Journal for the Philosophy of Science* 39 (1988) 389-95; 'What Place, Then, for a Creator?', *British Journal for the Philosophy of Science*, forthcoming; 'The Caused Beginning of the Universe: A Response to Quentin Smith', mimeograph (1989). Also see John Leslie, 'Anthropic Principle, World Ensemble, Design', *American Philosophical Quarterly* 19 (1982) 141-151, 'Modern Cosmology and the Creation of Life', in E. McMullin (ed.), *Evolution and Creation* (South Bend: University of Notre Dame Press, 1985) and numerous other articles.

by a quantum cosmology that is based on a fully developed quantum theory of gravity. Accordingly, my argument in this paper cannot be 'If the classical big bang theory is true, God does not exist; the classical theory is true, therefore God does not exist'. Rather, my argument is simply that the existence of God is inconsistent with the classical big bang theory. I aim to produce a valid argument for God's nonexistence, not a sound one.

There is also a second reason why the classical big bang theory cannot be viewed as the definitive theory of the universe. There are many other competing theories of the universe currently being considered, and some of these have at least as good a claim as the classical theory to be regarded as 'the best currently available theory' and 'the theory we should provisionally accept until the complete quantum cosmology is developed'. These competitors[2] include (a) Guth's original inflationary theory, (b) Linde's, Albrecht's and Steinhardt's new inflationary theory, (c) Linde's theory of chaotic inflation, (d) Tryon's, Gott's and others' theories that there are many universes (one of which is ours) that emerged as 'vacuum fluctuations' from a background empty space, (e) Hartle's and Hawking's theory that the universe's wave function is a function of three dimensional spatial geometries but not of a fourth temporal dimension, (f) Everett's theory of branching universes, and many other theories of current interest. In order to keep this paper within manageable limits, I shall not consider these competing theories but shall confine myself to the classical big bang theory. This confinement is consistent with my limited aim of counteracting the theistic interpretation of this classical theory.

In section II, I set forth, in a relatively nontechnical manner, the pertinent cosmological concepts. In section III, I offer an argument that these concepts are inconsistent with theism. In section IV-VII, I state and respond to some objections to this argument.

II. The Big Bang Cosmological Theory

The big bang theory is largely based on Friedmann's solutions to the so-called 'Einstein equation' that lies at the heart of the General Theory of Relativity. The details may be found in many textbooks and need only be

[2] See (a) A. Guth, 'Inflationary Universe: A Possible Solution to the Horizon and Flatness Problems', *Physical Review* D 23 (1981) 347-356; (b) A.D. Linde, 'A New Inflationary Universe Scenario', *Physical Letters* 108B (1982) 389-393, and A. Albrecht and P.I. Steinhardt, *Physical Review Letters* 48 (1982) 1220ff.; (c) A.D. Linde, 'The Inflationary Universe', *Reports on Progress in Physics* 47 (1984) 925-986; (d) E.P. Tryon, 'Is the Universe a Vacuum Fluctuation?', *Nature* 246 (1973) 396-397, and J.R. Gott, 'Creation of Open Universes from de Sitter Space', *Nature* 295 (1982) 304-307; (e) J.B. Hartle and S.W. Hawking, 'Wave Function of the Universe', *Physical Review* D 28 (1983) 2960-2975; (f) H. Everett ' "Relative State" Formulation of Quantum Mechanics', *Reviews of Modern Physics* 29 (1957) 454-462.

Some of these theories are discussed in Quentin Smith, 'World Ensemble Explanations', *Pacific Philosphical Quarterly* 67 (1986) 73-86 and 'The Uncaused Beginning of the Universe', *Philosophy of Science* 55 (1988) 39-57.

mentioned in passing[3] here. The ideas I wish to emphasise are the Hawking-Penrose singularity theorems and especially Hawking's principle of ignorance.

The singularity theorems are needed to show that the universe in fact began to exist in a big bang, for this conclusion cannot be derived from Friedmann's solutions and observation statements alone. Friedmann's solutions show that if the universe is *perfectly* homogeneous (matter is perfectly evenly distributed) and expanding, then the universe must have expanded from an initial state in the past when its radius was zero and the density of matter, temperature and curvature of the universe were all infinite. This initial state was a *singularity*, which implies that it was a beginning-point to spacetime; there is no earlier time than the instant of the singularity since the instant of the singularity is (by definition[4]) the first instant of time. The singularity exists for an instant and then explodes in the big bang, at which time the universe acquires a non-zero radius and a finite temperature, matter density and curvature. Now Friedmann's prediction of a big bang singularity required, as I emphasised, the assumption of a perfectly homogeneous universe. Since our universe is not perfectly homogeneous, the prediction of a singularity in our past seems unwarranted and the reasonable assumption seems to be that our universe began expanding after a prior phase of contraction. This assumption was adopted by many cosmologists until the mid and late 1960s, when Hawking and Penrose developed their *singularity theorems*, which were put forth as demonstrating that our universe *even if imperfectly homogeneous* began from a singularity. The theorems state that a big bang singularity is inevitable given the following five conditions, all of which were argued to hold true of the universe:

a) Einstein's General Theory of Relativity holds true of the universe.

[3] The Einstein equation reads

$$R_{ab} - \tfrac{1}{2}Rg_{ab} + \lambda g_{ab} = (8\pi G/c^2)\, T_{ab}$$

R_{ab} is the Ricci tensor of the metric g_{ab}, R is the Ricci scalar, λ is the cosmological constant (probably zero), c is the velocity of light and G is Newton's constant of gravitation. See Einstein's 'The Foundation of the General Theory of Relativity' and 'Cosmological Considerations on the General Theory of Relativity' in Einstein *et al.*, *The Principle of Relativity* (London: Dover, 1923).

The Friedmann solutions, with the cosmological constant omitted, are

$$-3(d^2a/dt^2 = 4\pi G(p+3P/c^2)a$$

$$3(da/dt)^2 = 8\pi Gpa^2 - 3kc^2$$

In these equations a is the scale factor representing the radius of the universe at a given time. da/dt is the rate of change of a with time; it is the rate at which the universe expands or contracts. d^2a/dt^2 is the rate of change of da/dt; it is the acceleration of the expansion or the deceleration of the contraction. G is Newton's gravitational constant and c the velocity of light. P is the pressure of matter and *p* its density. k is a constant which takes one of three values: 0 for a flat Euclidean space, -1 for a hyperbolic space, or +1 for a spherical space. See Alexander Friedmann, *'Uber die Krummung des Raumes', Zeitschrift für Physik* 10 (1922) 377-386; a translation of this paper appears in *A Source Book in Astronomy and Astrophysics*: 1900-1975 (eds.) K.R. Lang and O. Gingerich (Cambridge, Mass.: Harvard University Press, 1979). Friedmann's second paper on models with negative curvature was first published in *Zeitschrift für Physik* 21 (1924) 326.

[4] See, for example, B.G. Schmidt, 'A New Definition of Singular Points in General Relativity', *General Relativity and Gravitation* 1 (1971) 269-280, and S.W. Hawking and G.F.R. Ellis, *The Large Scale Structure of Space-Time* (Cambridge: Cambridge University Press, 1973).

b) There are no closed timelike curves (i.e. time travel into one's past is impossible and the principle of causality is not violated).
c) Gravity is always attractive.[5]
d) The spacetime manifold is not too highly symmetric; i.e., every spacetime path of a particle or light ray encounters some matter or randomly oriented curvature.[6]
e) There is some point p such that all the past directed (or future directed) spacetime paths from p start converging again. This condition implies that there is enough matter present in the universe to focus every past directed (or future directed) spacetime path from some point p.

The solutions for the Hawking-Penrose theorems in the general case show that there is a singularity that intersects every past-directed spacetime path and constitutes the beginning of time. Thus these solutions demonstrate, in Hawking's words, that even for imperfectly homogeneous universes 'general relativity predicts a beginning of time'.[7]

The singularity theorems are the part of big bang cosmology that support the claim that *there is* a big bang singularity. But the part of big bang cosmology that shall be crucial to my atheistic argument is the conception of the *nature* of this singularity. This conception is embodied in Hawking's *principle of ignorance*, which states that singularities are inherently chaotic and unpredictable. In Hawking's words,

> A singularity is a place where the classical concepts of space and time break down as do all the known laws of physics because they are all formulated on a classical space-time background. In this paper it is claimed that this breakdown is not merely a result of our ignorance of the correct theory but that it represents a fundamental limitation to our ability to predict the future, a limitation that is analogous but additional to the limitation imposed by the normal quantum-mechanical uncertainty principle.[8]

One of the quantum-mechanical uncertainty relations is $\triangle p \triangle q \geqslant h/4\pi$, which implies that if the position q of a particle is definitely predictable then the momentum p of the particle is not, and vice versa. The principle of ignorance implies that one can definitely predict neither the position nor the momentum of any particle emitted from a singularity.[9] All possible values of the particle's position and momentum that are compatible with the limited information (if any) available about the interaction region are equally

[5] That is, for any timelike vector V^a, the energy momentum tensor of matter satisfies the inequality $(T_{ab}-\frac{1}{2}g_{ab}T)\,V^a\,V^b \geqslant 0$.
[6] That is, any timelike or null geodesic contains some point at which $V_{[a}R_{b]cd[e}V_{f]}V^cV^d \neq 0$.
[7] S.W. Hawking, 'Theoretical Advances in General Relativity', *Some Strangeness in the Proportion*, (ed.) H. Woolf (Reading, MA: Addison-Wesley, 1980) p. 149.
[8] S.W. Hawking, 'Breakdown of Predictability in Gravitational Collapse', *Physical Review* D 14 (1976) 2460.
[9] See S.W. Hawking, 'Is the End in Sight for Theoretical Physics?', in *Stephen Hawking's Universe*, by John Boslough (New York: William Morrow and Co.) p. 145.

probable. But the principle of ignorance has further consequences. It implies that none of the physical values of the emitted particles are definitely predictable. The big bang singularity 'would thus emit all configurations of particles with equal probability'.[10]

If the singularity's emissions are completely unpredictable, then we should expect a totally chaotic outpouring from it. This expectation is consistent with big bang cosmologists' understanding of the early universe, for the early universe is thought to be in a state of maximal chaos (complete entropy). Particles were emitted in random microstates, which resulted in an overall macrostate of thermal equilibrium.[11]

It is important to understand the full significance of the principle of ignorance. If the big bang singularity behaves in a completely unpredictable manner, then no physical laws govern its behaviour. There is no law to place restrictions on what it can emit. As Paul Davies aptly comments, 'anything can come out of a naked singularity—in the case of the big bang the universe came out. Its creation represents the instantaneous suspension of physical laws, the sudden, abrupt flash of lawlessness that allowed something to come out of nothing.'[12] Here 'nothing' should be understood metaphorically as referring to something not a part of the four-dimensional spacetime continuum; the singularity is not a part of this continuum since it occupies less than three spatial dimensions. But Davies is literally correct in implying that the singularity entails an instantaneous state of lawlessness. The singularity exists for an instant and during this instant no physical law obtains that could connect the singularity to later instants. Given the initial conditions of the singularity, nothing can be predicted about the future state of the universe. Each possible configuration of particles has the same probability of being emitted by the singularity. (If there are uncountably infinite possible configurations, then we must speak instead of the probability density of each possible configuration and assign probabilities to each of the countable number of intervals of possible configurations, given an appropriate partition.) At any instant arbitrarily close to the instant at which the singularity exists, physical laws do obtain and they govern the particles actually emitted from the singularity. This means that for any physical configuration C that occupies an instant arbitrarily close to the instant occupied by the singularity from which C was emitted, there obtain laws connecting C to the configurations occupying later instants but there obtains no law connecting C to the earlier singularity. C adopts a lawful evolution but has its ultimate origin in primordial lawlessness.

III. The Atheistic Argument

I shall use the aspects of big bang cosmology explicated in the last section as the scientific premises of my atheistic argument. In this section I will

[10] S.W. Hawking, 'Breakdown of Predictability in Gravitational Collapse', *op. cit.*, p. 2460.
[11] *Ibid.*, p. 2463.
[12] P. Davies, *The Edge of Infinity* (New York: Simon and Schuster, 1981) p. 161.

add two theological premises and deduce the statement that God does not exist. Following the construction of this argument, I will state and respond to several objections to it (sections IV-VII). The real force of the argument will not become apparent until the responses to these objections are given.

The two theological premises I need are

(1) If God exists and there is an earliest state E of the universe, then God created E,
(2) If God created E, then E is ensured to either contain animate creatures or lead to a subsequent state of the universe that contains animate creatures.

Premise (2) is entailed by two more basic theological premises, viz.,

(3) God is omniscient, omnipotent and perfectly benevolent.
(4) An animate universe is better than an inanimate universe.

Given (4), if God created a universe that was not ensured to be animate, then he would have created a universe not ensured to be of the better sort and thereby would be limited in his benevolence, power or wisdom. But this contradicts (3). Therefore, (2) is true.

Some of the scientific ideas articulated in the last section, mainly the Hawking-Penrose singularity theorems, provide us with the summary premise

(5) There is an earliest state of the universe and it is the big bang singularity.

(5) requires a terminological clarification regarding 'the universe'. By this phrase I mean the 4D spacetime continuum and any n-dimensional physical state that is earlier or later than the 4D continuum. Since the universe has a zero radius at the singularity, it is not then 4D, but since the singularity is a physical state earlier than the 4D continuum it can be considered to be the first state of the universe (this is discussed further in section VI).

The scientific ideas also give us the premise

(6) The earliest state of the universe is inanimate since the singularity involves the life-hostile conditions of infinite temperature, infinite curvature and infinite density.

Another scientific idea enunciated in the last section, the principle of ignorance, gives us the summary premise

(7) The big bang singularity is inherently unpredictable and lawless and consequently there is no guarantee that it will emit a maximal configuration of particles that will evolve into an animate state of the universe. (A maximal configuration of particulars is a complete state of the universe, the universe as a whole at one time.)

(5) and (7) entail

(8) The earliest state of the universe is not ensured to lead to an animate state of the universe.

We now come to the crux of our argument. Given (2), (6) and (8), we can infer that God could not have created the earliest state of the universe. It then follows, by (1), that God does not exist.

I will now state and respond to four objections to this atheistic argument.

IV. The First Objection: Animate Universes Are Not Required by God

This objection is based on the principle that there is no universe that is the best of all possible universes. For each universe U_1 there is a better universe U_2. Consequently, the fact that there is some universe better than whatever universe is the actual one is not only compatible with divine creation but is entailed by it. Therefore, the objection goes, the fact that an animate universe is better than an inanimate one is compatible with God creating as the earliest state something that by chance leads to an inanimate universe. Premises (3) and (4) do not entail (2) and the atheistic argument therefore fails.

In response, I note first that many theists claim that there is a best of all possible universes and that God ensures that the one he creates is the best one. My argument implies at least that these theologies are mistaken. But it also tells against theologies that entail there is no best possible universe. These theologies, if they are at all consistent with what is ordinarily meant by 'God' and what most philosophers and theologians mean by 'God', must impose some minimal constraint on the value of the universe God creates. I believe the overwhelming majority of theists explicitly or implicitly accept the minimal constraint that the universe contain living creatures. The idea that God has no more reason to create an animate universe than an inanimate one is inconsistent with the kind of person we normally conceive God to be. The God of the Judeo-Christian-Islamic tradition is obviously a God who ensures that there be life in the universe he creates. This requirement conforms to the theism of Swinburne, Craig, Leslie, Plantinga, Adams, Morris, and all or virtually all other contemporary theists. Swinburne, for example, defines 'orderly universes' as the ones required by animate creatures and affirms that 'God has overriding reason to make an orderly universe if he makes a universe at all'.[13] According to this standard conception of God, premises (3) and (4) come with the suppressed premise

(4A) If God chooses to create a universe, he will choose to create an animate rather than an inanimate universe.

Given (4A), (3) and (4) do entail (2) and the atheistic argument is valid.

V. Second Objection: God Can Intervene to Ensure an Animate Universe

[13] R. Swinburne, *The Existence of God* (Oxford: Clarendon Press, 1979) p. 147. Swinburne's full definition is that orderly universes are those required by both natural beauty and life. Cf. p. 146.

The second objection is that the lawlessness of the big bang singularity is not logically incompatible with its being ensured by God to emit a life-producing maximal configuration of particles. For God could intervene at the instant of the singularity and supernaturally constrain the singularity to emit a life-producing configuration.

I believe this objection is incompatible with the rationality of God. If God intends to create a universe that contains living beings at some stage in its history, then there is no reason for him to begin the universe with an inherently unpredictable singularity. Indeed, it is positively irrational. It is a sign of incompetent planning to create as the first natural state something that requires immediate supernatural intervention to ensure that it leads to the desired result. The rational thing to do is to create some state that *by its own lawful nature leads* to a life-producing universe.

This response to the second objection can be developed in the context of a discussion of John Leslie's interpretation of big bang cosmology. Leslie points to data or figures (the 'anthropic coincidences') that suggest it is *highly improbable* that an animate universe would result from a big bang singularity.[14] There are many possible maximal configurations of particles that might be emitted from the singularity and only an extremely small number of these, Leslie suggests, lead towards animate states. But Leslie argues that this improbability tells *for* rather than against the hypothesis of divine creation. (I should note that Leslie works with a 'Neoplatonic' conception of God[15] but that makes no substantive difference to the validity of the arguments I shall examine.) He implies that if we suppose that God constrained the singularity's explosion to be directed away from the more probable alternatives of lifelessness and towards the very narrow range of alternatives that lead to life, then we can 'explain away' the apparent improbability of an animate universe evolving from the singularity. The alleged simplicity of this explanation, the distinctive value of life, and other relevant premises, are regarded as making this explanation a credible one. But this fails to take into account the above-mentioned problem regarding God's rationality and competence, which appears here in an aggravated form. It seems to me that Leslie's premise that it is highly improbable that the big bang singularity would (if left to evolve naturally) lead to an animate universe is *inconsistent* with the conclusion that God created the singularity. If God created the universe with the aim of making it animate, it is illogical that he would have created as its first state *something whose natural evolution would lead with high probability only to inanimate states.* It does not agree

[14] See Leslie's articles mentioned in footnote 1.

[15] For Leslie, 'God' means one of two things. God 'may be identified as the world's creative ethical requiredness [i.e. the ethical requiredness that created the universe] . . . Alternatively [God may be identified] as an existing person, a person creatively responsible for every other existence, who owed his existence to his ethical requiredness.' See his 'Efforts to Explain All Existence', *Mind* 87 (1978) p. 93. On the second conception of God, God as a person, it is appropriate to refer to him with a personal pronoun ('he'). But on the first conception, the impersonal pronoun 'it' is more appropriate. For simplicity's sake, I use 'he' in the main body of the paper.

with the idea of an efficient creation of an animate universe that life is brought about through the first state being created with a natural tendency towards *lifelessness* and through this tendency being *counteracted* and *overridden* by the very agency that endowed it with this tendency. The following two propositions appear to be logically incompatible:

(1) God is a rational and competent creator and he intends to create an animate universe,
(2) God creates as the first state of the universe a singularity whose natural tendency is towards lifelessness.

The problem involved here is essentially a problem of divine interference in or 'correction of' the divine creations. Leslie is 'opposed'[16] to the idea of 'divine interference' with natural processes and is unsympathetic to the idea that 'God occasionally intervenes [in the natural universe] with a helpful shove'[17] so as to ensure that life evolves. Leslie states that the hypothesis of such intervention involves an unsimple theory and for this reason is to be dispreferred. But such intervention is precisely what is required by his own account of the evolution of the early universe. His account supposes that God not only interferes with the singularity's explosion but also interferes with the subsequent evolution of the maximal configuration of particles that was emitted from the singularity. For example, Leslie mentions the theory that the early universe underwent a number of 'spontaneous symmetry breaking phases' during the first 10^{-4}second after the big bang singularity and that during these phases the four forces (gravitational, strong, weak and electromagnetic) became separated. In the GUT era (from 10^{-43}second after the singularity to 10^{-35}second) the gravitational force is separated from the strong-electroweak force. During the electroweak era (from 10^{-35}second to 10^{-10}second) the strong force is separated from the electroweak force. During the free quark era (from 10^{-10}second to 10^{-4}second) the electromagnetic force is separated from the weak force. Each of these separations is a breaking of a symmetry (the unification of two or more forces) and each symmetry is broken in a random way. This means, in effect, that the strengths of the four forces are determined in random ways at the time they become separated. This is significant, Leslie indicates, since only a small range of the values these forces may possess are consistent with a life-supporting universe. For example, if the actual value of the weak fine structure constant ($a_w \sim 10^{-11}$) were slightly larger, supernovae would have been unable to eject the heavy materials that are necessary for organisms. If this value were slightly smaller, no hydrogen would have formed and consequently no stars and planets would have evolved. Similar considerations hold for the gravitational, electromagnetic and strong forces. Given this, Leslie continues, it is 'exceedingly improbable'[18] that these symmetry breaking phases would have resulted in the very narrow range of values required

[16] Leslie, 'Modern Cosmology and the Creation of Life', *op. cit.*, p. 112.
[17] *Ibid.*, p. 92.
[18] *Ibid.*, p. 95.

by a life-supporting universe. This improbability could be eliminated if we supposed that these values were not selected by natural random processes but were 'selected by God'. But this requires divine interference on a grand scale in the evolution of the universe. God would have to intervene in his creation at the big bang singularity to ensure that it emitted a maximal configuration of particles capable of undergoing the symmetry breaking phases, *then again* during the GUT era to ensure that the separating gravitational force acquires the right value, *and then once again* during the electroweak era to ensure that the separating strong force acquires the right value, *and then once more* during the free quark era to ensure that the separating electromagnetic and weak forces acquire the right value. And these are only some of the interventions required (I have not even mentioned, for example, the interventions required to ensure that the elementary particles acquire the right masses). But why does Leslie think his theory avoids the implausibly complex theory of repeated divine interventions in natural processes? Because he *stipulates* that God's fixing of the values of the constants are not instances of such interventions. Interventions he defines as applying to less basic aspects of nature (such as creations of individual animal organisms).[19] But this stipulation seems arbitrary and implausible. If God's interference with the singularity's emission of particles and with the several symmetry breaking phases are not examples of God interfering with natural states and processes, then I don't know what is.

Leslie suggests that the notion of divine interference with the processes of nature is implausible because it is less simple than the idea that God lets nature evolve on its own. But it seems to me there is a more fundamental problem with this notion, at least as it applies to Leslie's scenario. This notion, in the context of Leslie's scenario, implies that the universe God created was so bungled that it needed his repeated intervention to steer it away from disaster and towards the desired life-producing states. God created a universe that time and again was probably headed towards *the very opposite result than the one he wanted* and only through interfering with its natural evolution could he ensure that it would lead to the result he desired. But this contradicts the principle that God is not a bungler ('a competent Creator does not create things he immediately or subsequently needs to set aright').

I should make explicit that the key idea in my argument is not that God is incompetent if he creates a universe whose laws he must *violate* if his intentions are to be realised, but that he is incompetent if he creates a universe requiring his *intervention* if his intentions are to be realised. A divine intervention in natural events is entailed by, but does not entail, a divine violation of natural laws, since God may intervene in an event (e.g. the explosion of the singularity) not governed by laws. Thus, the possible objection to my argument that 'if physical laws under-constrain the evolution of the universe, then God can constrain the universe to evolve into animate states

[19] *Ibid.*, pp. 91 and 112.

without violating his physical laws' misses the point, that *intervention*, not violation, is the problem. However, if we assume Leslie's scenario, then we can say there are not only interventions but also violations, since in his scenario there are probabilistic laws governing the early evolution of the universe (which includes the symmetry breaking phases) and God suspends (violates) these laws to ensure that the improbable life-producing outcomes result.

My conclusion is this. There are countless logically possible initial states of the universe that lead by a natural and lawlike evolution to animate states and if God had created the universe he would have selected one of these states. Given that the initial state posited by big bang cosmology is not one of these states, it follows that big bang cosmology is inconsistent with the hypothesis of divine creation.[20]

VI. Third Objection: The Singularity is a Theoretical Fiction

The theist may attempt to avoid the difficulties of an unpredictable initial state and a divine intervention by supposing that the initial state of the universe is not an unpredictable singularity. The theist may continue to accept big bang cosmology except that she adopts rules for the interpretation of this theory that forbid reality to the singularity. These rules are based on a criterion of physical existence that the singularity fails to meet but which is met by the big bang explosion. These rules allow the theist to regard the big bang explosion, not the singularity, as the earliest state of the universe. (But now 'state' must be understood as a temporally extended state of a certain length rather than as an instantaneous one since the explosion is extended.) The big bang explosion is governed by physical laws and this explosion leads by a natural and lawful evolution to a state of the universe that contains animate creatures. The problem of God creating as the first state some totally unpredictable state is thereby avoided and the theist is

[20] I would add that my argument does not require that God create an animate universe in the most efficient way possible, since there may be no 'most efficient way possible', but merely that he create it in an efficient way (which minimally requires that no interventions be needed). Somewhat analogously, Keith Chrzan has soundly argued that 'there is no best possible world' does not entail 'there is no world without evil' and therefore that the 'no best possible world' theodicy fails to demonstrate that evil is a necessary implication of creation and thus fails to explain how God's existence is compatible with the actual world. See Keith Chrzan, 'The Irrelevance of the No Best Possible World Defence', *Philosophia* 17 (1987) 161-167. The analogy can be seen if we substitute 'most efficient' for 'best possible' and 'without divine intervention' for 'without evil' in the above sentences. I also reject the supposition that the Hawking-Penrose theorems and the principle of ignorance are *metaphysically necessary* laws of nature and therefore that God had no alternative to creating a singularity that required his intervention. In his interesting article on 'Explaining Existence', *Canadian Journal of Philosophy* 16 (1986) 713-22, Chris Mortensen entertains the supposition that the laws governing the beginning of the universe are necessary, but concludes, soundly I believe, that this supposition is not particularly credible. I would add that the Kripke-Putnam argument that some laws are necessary (e.g. that water is H_20), even if sound, does not apply to the singularity theorems, for the Kripke-Putnam argument applies only to laws involving ostensively defined terms (e.g. 'water') and 'singularity' is not ostensively defined. See Jarrett Leplin, 'Is Essentialism Unscientific?', *Philosophy of Science* 55 (1988) 493-510 and 'Reference and Scientific Realism', *Studies in History and Philosophy of Science* 10 (1979) 265-85.

able to ascribe a rational behaviour to God in creating as the first state something that naturally evolves into an animate universe.

In dealing with this third objection I shall ignore the problem of the unpredictable symmetry breaking phases that Leslie introduces into his scenario and that would seem to vitiate the hypothesis that the big bang explosion predictably evolves into animate states. Although it is widely—but not universally—accepted today that such phases occur, these phases are not entailed by classical big bang cosmology and accordingly it is not appropriate to introduce them when criticising theistic interpretations of this cosmology that do not themselves introduce the phases. Thus, in responding to the third objection I will not argue that there remain unpredictabilities even if the singularity is omitted but will argue instead that there is no justification for rejecting the singularity with its unpredictability.

Let me begin by noting that the description or definition of the big bang singularity as a mere idealisation does *not* belong to big bang cosmology itself and thus that if this view of the singularity is to be justified some strong and independent philosophical arguments will be needed. Big bang cosmology represents the singularity as a unique sort of reality, a *physical singularity*, but it is represented as real nonetheless. This is evinced by the fact that past-directed spacetime paths in the early universe are not modelled on half-open intervals that approach arbitrarily close to but never reach the ideal limit, but on closed intervals one of the endpoints of which is the singularity. In the words of Penrose, 'the essential feature of a past spacelike singularity [the big bang singularity] is that it supplies a past singular end-point to the otherwise past-endless timelike curve'.[21] (A timelike curve is a spacetime path of a particle.) In the words of Geroch and Horowitz, converging past-directed spacetime paths are not commonly thought to merely approach with arbitrary closeness the same singular point but are thought to actually '*reach* the same singular point',[22] which requires the actual physical existence of the singular point. Furthermore, this point is thought by physicists to be earlier in time than the big bang explosion. Penrose articulates the common view that in the case of a finite universe 'we think of the initial singularity as a single point . . . [which] *gives rise to an infinity of causally disconnected regions at the next instant*',[23] a conception

[21] R. Penrose, 'Singularities in Cosmology', in *Confrontation of Cosmological Theories with Observational Data* (ed.) M.S. Longair (Dordrecht: Reidel, 1974) p. 264. Penrose shows how the zero dimensional singularity can be conformally rescaled as a three dimensional singularity, which testifies further to the fact that the singularity is thought of as something real.

[22] R. Geroch and G. Horowitz, 'Global Structure of Spacetime', in *General Relativity* (eds.) S.W. Hawking and W. Isreal (New York: Cambridge University Press, 1979) p. 267. Geroch and Horowitz go on to argue for the nonstandard position that a study of the global properties of singular spacetimes is a more fruitful line of research than attempts to provide constructions of local singular points.

[23] Penrose, *op. cit.*, p. 264; the italics are mine. Penrose is best interpreted as speaking loosely in this passage, for strictly speaking there is no 'next instant' after the instant of the singularity (if time is dense or continuous) and the singular point does not topologically transform to an 'infinite' number of causally disconnected regions but to an arbitrarily large finite number.

that clearly entails the physical and temporal reality of the initial singularity.

Given this realist representation of the singularity, the theists must have strong reasons indeed to support the interpretation of the singularity as a mere idealisation. They must establish some convincing criterion of physical existence and show that the singularity fails to meet this criterion. This has been attempted by William Lane Craig. Craig argues that no infinitely complex object can be real and the singularity cannot be real since it has infinite values, such as infinite density; 'there can be no object in the real world that possesses infinite density, for if it had any mass at all, it would not be *infinitely* dense'.[24] Craig's arguments against infinite realities in his book are aimed at showing that no reality can be mapped onto a Cantorian transfinite set. I have elsewhere[25] countered Craig's arguments but I would like to show here that even if his arguments were sound they would not count against the reality of the big bang singularity. When it is said that the big bang singularity has an infinite density, infinite temperature, and infinite curvature, it is not being said that the singularity has parts or properties that map onto a set with an aleph-zero or aleph-one cardinality. Rather, three things are implied and each of them is compatible with Craig's rejection of Cantorian realities:

The theory that there is an infinite singularity implies, first of all, that at any instant arbitrarily close to the big bang singularity the density, temperature and curvature of the universe have arbitrarily high finite values. The values become higher and higher as we regress closer and closer to the singularity, such that for any arbitrarily high finite value there is an instant at which the density, temperature and curvature of the universe possess that value.

The theory of the infinite singularity implies, secondly, that when the singularity is reached the values become infinite. But this does *not* mean that the density, temperature and curvature of the universe have values involving the numbers $\aleph_0$ or $\aleph_1$. Consider the phenomenon of density, which is the ratio of mass to unit volume (density=mass/volume). If the universe is finite and the big bang singularity a single point, then at the first instant the entire mass of the universe is compressed into a space with zero volume. The density of the point is $n/0$, where n is the extremely high but finite number of kilograms of mass in the universe. Since it is impermissible to divide by zero, the ratio of mass to unit volume has no meaningful and measurable value and *in this sense is infinite.* Although philosophers frequently misunderstand this use of the word 'infinite' by physicists, this usage has been clearly grasped by Milton Munitz in his recent discussion of the big bang theory. He notes that—

[24] W.L. Craig, *The Kalam Cosmological Argument, op. cit.*, p. 117.

[25] *Vide*, 'Infinity and the Past', *Philosophy of Science* 54 (1987) 63-75 and section 6 of 'A New Typology of Temporal and Atemporal Permanence', *Noûs* 23 (1989) 307-330. For a correction to one of my arguments in 'Infinity and the Past' see Ellery Eells, 'Quentin Smith on Infinity and the Past', *Philosophy of Science* 55 (1988) 453-455.

> the density of a homogeneous material is mass per unit volume—for example, grams per cubic centimeter. Given both a zero value and the conservation of the mass-energy of the universe [at the big bang singularity], no finite value can be given to the ratio of the latter to the former (it is forbidden to divide by zero). This is normally expressed by saying that the density becomes *infinite*. It would be more accurate to say the standard meaning of 'density' cannot be employed in this situation. The density cannot be assigned a finite measurable value, as is the case in all standard applications of the concept.[26]

The theory of the infinite singularity implies, thirdly, that the space of the singularity topologically transforms into the three dimensional space of the universe at the big bang explosion. It is a familiar notion in the mathematical discipline of topology that a space with a topology of a point can assume the topology of a finite 3D space. The topological transformation of the OD space to the 3D space is precisely the big bang explosion. But I am not saying here that the OD space is homeomorphic to the 3D space, where x is homeomorphic to y if there exists a continuous bijective map f of x onto y such that the inverse map f^{-1} is also continuous. Rather, I am saying that a space with the topology of a point assumes, at a subsequent time, the topology of a finite 3D space. Such topological transformations are possible but it is not possible, for instance, for a space with the topology of a point to assume, at a subsequent time, the topology of an infinite 3D space (where 'infinite' is used in the Cantorian sense). If our universe is infinite, then the big bang singularity must have consisted of an infinite number of points and must have been at least 1D, with each of the points 'topologically exploding' into a different finite 3D region. Paul Davies comments that if the universe is finite—

> one can really suppose that the entire universe began compressed into one point. On the other hand, if space is infinite, we have the mathematically delicate issue of conflicting infinities, because infinitely extended space becomes infinitely compressed at the beginning of the big bang. This means that any given *finite* volume of the present universe, however large one chooses it to be, was compressed to a single point at the beginning. Nevertheless, it would not be correct to say *all* the universe was at one place then, for there is no way that a space with the topology of a point can suddenly assume the topology of a space with infinite extent.[27]

It might be conceded that the notion that the singularity is real escapes Craig's criticism, since it is not 'infinite' in a Cantorian sense, but argued that the concept of the singularity is defective for other reasons. For example, how can the entire mass of a finite universe be compressed into a point? The mass is 3D and the point is OD, which involves a contradiction. But this is a misunderstanding. The mass as compressed into the point is not

[26] Milton Munitz, *Cosmic Understanding* (Princeton: Princeton University Press, 1986) p. 111.
[27] Paul Davies, *The Edge of Infinity*, *op. cit.*, p. 159.

ordinary mass, 3D mass, but *infinitely compressed mass*, which means that it has lost its three dimensionality and assumed the dimensionality of the point it occupies. The assertion that at the instant of the singularity, *n* kilograms of mass is infinitely compressed in a zero volume, implies in part that (i) at this instant there exists no 3D mass, (ii) at this instant there exists only one OD point, that (iii) this point subsequently assumes the typology of a 3D space, and that (iv) this subsequent 3D space is occupied by *n* kilograms of mass. Of course this singular point can assume the typology of a 3D space that contains *any* finite number of kilograms of mass—the actual number, *n*, is randomly 'selected' from the range of possibilities—and this is one of the reasons the singularity is wholly unpredictable.

I believe, therefore, that there is no good reason for rejecting the reality of the big bang singularity and the attendant unpredictability. If Craig is to justify his claim that the assumption that it is real it is an illegitimate 'ontologising' of a mathematical construct, he must provide some reason to support this claim other than his arguments against Cantorian infinities. His recent and related claim that 'a physical state in which all spatial and temporal dimensions are zero is a mathematical idealisation whose ontological counterpart is nothing'[28] is made with no effort to support it and should be rejected as an unjustified scepticism about a widely held scientific thesis.

VII. Fourth Objection: Unpredictability Does not Entail There is no Divine Knowledge

I have said the big bang singularity is unpredictable. It might be objected that the fact that *we* cannot predict what comes out of the singularity is consistent with God being able to predict what will emerge from it. God is omniscient, which implies he can know things that are unknowable by humans.

But this objection is based on several questionable assumptions, one of which concerns the meaning of the word 'unpredictable' as it is used in the formulation of Hawking's principle of ignorance. What is meant is *unpredictability in principle*, which entails but is different from *unpredictability by us*. The qualifier 'in principle' is added to indicate that the unpredictablility is due to the fact that *no natural laws govern the state(s)*. If something is merely unpredictable by us, that is consistent with saying that it is governed by a natural law that is not knowable by humans. But if there is an 'in principle' unpredictability, then there is no natural law to be known, by God or any other knower. Since there is no natural law governing the singularity, God has no basis on which to compute what will emerge from the singularity. As Davies says, the instantaneous existence of the singularity and the subsequent explosion is an 'abrupt flash of lawlessness'.

[28] W.L. Craig, 'The Caused Beginning of the Universe: A Response to Quentin Smith', *op. cit.*, p. 8.

Some might claim that 'unpredictability in principle' as used in quantum mechanics (and thus in Hawking's theory, which is partly based on quantum mechanics) should be interpreted as meaning the same as 'unpredictability by us' since the most plausible interpretations of quantum mechanics (e.g. the Copenhagen interpretation) are anti-realist. But this claim, while perhaps justified on the old assumption that the Everett interpretation is the only realist one consistent with quantum mechanics, is not justified today, given that some plausible realist interpretations have been recently developed, such as, for example, Storrs McCall's 'branched model' interpretation.[29]

But this reference to a realist interpretation of the singularity's unpredictability does not do full justice to the objection that 'unpredictability does not entail there is no divine knowledge'. For the objector might claim that God can 'know in advance' the result of the singularity's explosion *even if there is no law on the basis of which he can form a prediction.* It might be said that just as God knows, logically prior to creation, the free decisions humans would make if they were in certain circumstances, so he knows, logically prior to creation, the way the singularity would explode if it were to be the first state of the universe. The theist may allege that in addition to the familiar sorts of counterfactuals, we may introduce a new sort, 'counterfactuals of singularities', one of which is the counterfactual

(1) If a big bang singularity were to be the earliest state of the universe, this singularity would emit a life-producing configuration of particles.

The theist may allege that (1) is true logically prior to creation and that God's pre-creation knowledge of (1) serves as his reason for his creation of a universe with a big bang singularity.

But this argument is unsound, since the supposition that (1) is true logically prior to creation is inconsistent with the semantic properties of counterfactuals. As Jonathan Bennett and Wayne Davies have argued,[30] counterfactuals are true *iff* the antecedent and consequent are both true in the possible world most similar to the actual world *before* the time specified in the antecedent. This entails that there are no possible conditions in which (1) is true, since the time specified in its antecedent is the earliest time.

But the theist need not accept the Bennett-Davies theory of counterfactuals. He may accept one of the theories of Robert Stalnaker, Richmond Thomason and Frank Jackson,[31] according to which a counterfactual is true *iff* its antecedent and consequent are both true in a possible world whose *total history* is most similar to that of the actual world. Or the theist may accept

[29] Storrs McCall, 'Interpreting Quantum Mechanics Via Quantum Probabilities', mimeograph, 1989.

[30] Jonathan Bennett, 'Counterfactuals and Possible Worlds', *Canadian Journal of Philosophy* 4 (1974) 381-402; Wayne Davies, 'Indicative and Subjunctive Conditionals', *The Philosophical Review* 88 (1979) 544-64.

[31] Robert Stalnaker, 'A Theory of Conditionals' in N. Rescher (ed.) *Studies in Logical Theory* (Oxford: Blackwell, 1968) 92-112; Richmond Thomason and Robert Stalnaker, 'A Semantic Analysis of Conditional Logic', *Theoria* 36 (1970) 23-42; Frank Jackson, 'On Assertion and Indicative Conditionals', *The Philosophical Review* 88 (1979) 565ff.

David Lewis's theory,[32] that counterfactuals are true *iff* some world in which the antecedent and consequent are both true is more similar in its overall history to the actual world than any world in which the antecedent is true and the consequent false.

But these theories of counterfactuals are of no avail since they one and all entail that a counterfactual is true only if *there is an actual world* that serves as a relatum of the similarity relation. According to the Bennett-Davies theories, the relatum is all the states of the actual world up to a certain time and according to the theories of Stalnaker, Lewis and others, the relatum is all the states of the actual world. Since (1) is supposed to be true logically prior to creation, its truth-conditions cannot include all the states (or all the states up to a time) of the actual world, which contradicts the truth-condition requirements of counterfactuals.

But a theist familiar with the corpus of William Lane Craig might be able to come up with a response to this argument. Craig does not discuss 'counterfactuals of singularities' but he does discuss counterfactuals of freedom and some of his arguments may be borrowed by a defender of the truth of (1). In response to the objection that there is no actual world logically prior to creation in relation to which counterfactuals of freedom could be evaluated as true, Craig maintains that a part of our world is actual prior to creation, namely the part consisting of logically necessary states of affairs and counterfactual states of affairs concerning the free decisions of creatures. 'Since the relevant states of affairs are actual, one can hold to both the doctrine of divine middle knowledge [i.e. that God knows counterfactuals of freedom prior to creation] and the current explanation of what it means for a counterfactual to be true: in those possible worlds which are most similar to the actual world (insofar as it exists at [this logical] moment [prior to creation]) and in which the antecedent is true, the consequent is also true.'[33]

But this response in untenable, since the current explanation of counterfactuals is that their truth conditions include either *all the states of the actual world* or *all the states of the actual world earlier than a certain time*, and the counterfactuals that are allegedly objects of God's middle knowledge meet neither of these two requirements. They are supposed to be true logically prior to the creation of the earliest state and therefore cannot include in their truth conditions all the states of the actual world or all the states earlier than a certain time.

Of course, the theist may reject the current explanation of counterfactuals. He may hold that counterfactuals of freedom (or of singularities) are true *iff* their antecedents and consequents are both true in the possible world most similar to the actual world *insofar as the actual world exists at the moment logically prior to creation.* This seems to be Craig's position, although he mistakenly claims it is consistent with 'the current explanation of what

[32] David Lewis, *Counterfactuals* (Cambridge: Harvard Univ. Press, 1973).

[33] W.L. Craig, *The Only Wise God: The Compatibility of Divine Foreknowledge and Human Freedom* (Grand Rapids: Baker Book House, 1987) p. 144.

it means for a counterfactual to be true'. Now Craig holds, as we have seen, that at this logically prior moment there obtain all logically necessary states of affairs and all counterfactual states of affairs concerning free decisions of creatures. In response to the objection that counterfactuals of freedom cannot be true at this logically prior moment, since the actual world is not then actual, he claims that it is partly actual, since it includes in part the counterfactual states of affairs, i.e. the 'states of affairs corresponding to true counterfactuals concerning creaturely freedom.'[34] But this argument is viciously circular. In order to demonstrate that counterfactuals of freedom are true logically prior to creation, it is assumed that counterfactuals of freedom are true logically prior to creation, i.e. that prior to creation there are 'states of affairs corresponding to true counterfactuals concerning creaturely freedom'. To avoid this vicious circle, we must allow only the premise that there obtain logically necessary states of affairs prior to creation. But this premise is insufficient to establish the desired conclusion, since these states of affairs cannot ground the relations of trans-world similarity required by logically contingent counterfactuals, the counterfactuals of freedom. It follows, then, that no sound argument can be constructed, in analogy to Craig's argument about counterfactuals of freedom, for the thesis that the 'counterfactual of singularity' (1) is true logically prior to creation. It is logically incoherent to suppose that (1) is true logically prior to creation and therefore the fact that God is omniscient does not entail that he knows, logically prior to creation, that the big bang singularity would evolve into an animate universe.

VIII. Conclusion

If the arguments in this paper are sound, then God does not exist if big bang cosmology, or some relevantly similar theory, is true. If this cosmology is true, our universe exists without cause and without explanation.[35] There are numerous possible universes, and there is possibly no universe at all, and there is no reason why this one is actual rather than some other one or none at all. Now the theistically inclined person might think this grounds for despair, in that the alleged human need for a reason for existence, and other alleged needs, are unsatisfied. But I suggest that humans do or can possess a deeper level of experience than such anthropocentric despairs. We can forget about ourselves for a moment and open ourselves up to the startling impingement of reality itself. We can let ourselves become profoundly astonished by the fact that this universe exists at all. It is arguably a truth of the 'metaphysics of feeling' that this fact is indeed 'stupefying'

[34] *Ibid.*, p. 143.

[35] Big Bang cosmology may be modified in certain fundamental respects so that our universe has an explanation in terms of other universes, but the set of all universes will nonetheless remain unexplained. See Quentin Smith, 'A Natural Explanation of the Existence and Laws of Our Universe', *Australasian Journal of Philosophy* 68 (1990) 22-43.

and is most fully appreciated in such experiences as the one evoked in the following passage:[36]

> [This world] exists nonnecessarily, improbably, and causelessly. It exists *for absolutely no reason at all.* It is *inexplicably* and *stunningly actual* . . . The impact of this captivated realisation upon me is overwhelming. I am completely stunned. I take a few dazed steps in the dark meadow, and fall among the flowers. I lie stupefied, whirling without comprehension in this world through numberless worlds other than this one.[37]

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[36] Quentin Smith, *The Felt Meanings of the World: A Metaphysics of Feeling* (West Lafayette: Purdue University Press, 1986) pp. 300-301. In an important study, Milton Munitz has plausibly argued that it is *possible* that there is a reason for the existence of the universe, such that this reason is not a 'reason' in the sense of a purpose, cause, scientific explanation, or evidence (justification) for a belief or statement, but in some unique sense not fully comprehensible by us. This argument is consistent, of course, with the position that there actually is no reason for the existence of the big bang universe and that it is not possible that this universe has a cause or purpose. See his *The Mystery of Existence: An Essay in Philosophical Cosmology* (New York: Appleton-Century-Crofts, 1965) especially Part Four and the Conclusion.

[37] I am grateful to Richard Fallon and two anonymous referees for helpful comments on an earlier version of this paper.