

THOMAS AQUINAS AND BIG BANG COSMOLOGY

Contemporary cosmologists in their fascination about the beginning of the universe echo Aristotle's observation that the «beginning of anything is the most important part, being indeed half of the whole»¹. As Aristotle notes in the *Poetics*², a beginning is that which does not have anything necessarily before it but does have something necessarily following from it. «Beginning» is a relative term; it is used in many contexts, and, as we will see, confusion in analyses about beginnings pervades almost all of current cosmological reflection on the beginning of the universe. Here again Aristotle offers a helpful warning: a small mistake in the beginning can produce large distortions in what follows.

Recent studies in particle physics and astronomy have produced dazzling speculations about the early history of the universe. Cosmologists now routinely entertain elaborate scenarios which propose to describe what the universe was like when it was the size of a softball, a mere 10^{-35} second after the Big Bang. The description of the emergence of four fundamental forces and twelve discrete subatomic particles is almost a common-place in modern physics. There is little doubt among scientists that we live in the aftermath of a giant explosion which occurred around 15 billion years ago —give or take a few billion³.

The story of the gradual acceptance of Big Bang cosmology begins with the initial arguments for it by Georges Lemaître, George Gamow, and others in the late 1920s and 1930s⁴. Lemaître was able to combine Einstein's theory of relativity with

¹ *Problems X*: 892 a 30-33.

² *Poetics VII*: 1450 b 27-29.

³ Although in a distinct minority, there still are some prominent scientific critics of Big Bang cosmology. H. C. Arp rejects the correlation of red-shift with distances of galaxies, and Eric Lerner argues that the theory of a Big Bang cannot account for the formation of galaxies. See H. C. ARP, *et al.*, «The Extragalactic Universe: An Alternate View»: *Nature* 346 (1990) 807-812; and E. LERNER, *The Big Bang Never Happened: A Startling Refutation of the Dominant Theory of the Universe* (New York: Random House, 1991). Lerner's book appeared before the discoveries of the COBE satellite, noted below. These references come from E. McMullin's essays cited in note 11 below.

⁴ Helge Kragh's *Cosmology and Controversy: The Historical Development of Two Theories of the Universe* (Princeton, NJ: Princeton University Press, 1996) is an excellent comprehensive history of the development of the big bang and steady-state theories of the universe. Kragh points out that arguments for an expanding universe —made particularly credible by Hubble's discoveries of the «red-shift»— do not necessarily include the idea of a primal big bang. In a popular account of Hubble's discoveries, written in 1929, H. N. Russell asked, «Are the nebulae really flying out in all directions —away from us and therefore from one another— so that the universe of nebulae is expanding without limits into the depths of space? [...] The best answer that has yet been suggested comes from a pecu-

the astronomical observations of Edwin Hubble⁵ to propose the theory that the entire universe is evolving in time from a «primeval atom», a superdense state of matter that somehow «exploded». Since the history of science is frequently written from the point of view of the winners, it is easy to forget how controversial the claim was that the universe is expanding⁶.

Two major discoveries have solidified support for Big Bang cosmology in the scientific community. In 1965 cosmic microwave background radiation was discovered. This uniformly distributed, very low temperature radiation was seen to be a relic of the «primeval fireball» of the universe. It was not until 1992 that cosmologists were satisfied that they could explain the emergence of galaxies from the smooth, uniform initial state of the universe. The requisite irregularities or discontinuities necessary to account for galaxies were revealed by COBE, the Cosmic Background Explorer satellite. George Smoot, head of the COBE research team, describes the discovery of these irregularities in the microwave background in his book, *Wrinkles in Time*. The discovery was acclaimed as the finding of the Holy Grail of cosmology; Smoot likened it to «looking into the face of God». Stephen Hawking announced that «it was the discovery of the century, if not of all time»⁷.

John Gribbin, an astrophysicist at Cambridge University, summarizes the importance of Big Bang cosmology in this way: «the discovery of the century, in cosmology at least, was without doubt the dramatic discovery made by Hubble, and confirmed by Einstein's equations, that the Universe is not eternal, static, and unchanging»⁸. In 1988, Hawking observed that as a result of Big Bang cosmology the question of the beginning of the universe entered «the realm of science»⁹. More recently he has argued that we can have no scientific theory of nature unless the theory accounts for the beginning of the universe.

liar form of the theory of relativity suggested a few years ago by the great Dutch astronomer de Sitter. [...] It would be premature, however, to adopt de Sitter's theory without reservation. The notion that all the galaxies were originally close together is philosophically rather unsatisfactory». See «The Highest Known Velocity»: *Scientific American* 140 (1929) 504-5. Kragh notes that the theoretical framework of an expanding universe owes its origin to the Soviet physicist Alexander Friedmann and the Belgian priest-scientist Georges Lemaître (Cf. H. KRAGH, *op. cit.*, pp. 22-79). Lemaître's «version of relativistic big-bang cosmology did not attract much interest [...] and it was only after George Gamow had developed it further, along his own lines, that the foundation of modern big bang cosmology was laid» (H. KRAGH, *op. cit.*, p. xi).

⁵ For an excellent new biography of Hubble, see Gale CHRISTIANSON, *Edwin Hubble: Mariner of the Nebulae* (Chicago: The University of Chicago Press, 1995).

⁶ Albert Einstein, in order to protect the view that the universe is static, was led to introduce his famous cosmological constant. Kragh observes that, immediately after World War I, the two competing general-relativistic models of the universe, Einstein's and de Sitter's, despite their differences, were both static models. Kragh also provides an interesting discussion of the competition between purely mathematical and physical discussions of these models. Cf. H. KRAGH, *op. cit.*, pp. 12 ff. Einstein, of course, eventually came to embrace the view of an expanding universe.

⁷ It is important to recognize that COBE's discoveries only remove an objection to Big Bang cosmology.

⁸ John GRIBBIN, *In the Beginning: The Birth of the Living Universe* (Boston: Little, Brown and Company, 1993), p. 19.

⁹ Stephen HAWKING, *A Brief History of Time* (New York: Bantam Books, 1988), p. 8.

«The only way to have a scientific theory is if the laws of physics hold everywhere, including at the beginning of the universe. One can regard this as a triumph of the principles of democracy: why should the beginning of the universe be exempt from the laws that apply to other points? If all points are equal, one can't allow some to be more equal than others»¹⁰.

This confidence that cosmology now can address the beginning of the universe—a confidence shared by many cosmologists—has led to all sorts of speculations about the initial state of the universe. For many scientists, philosophers, and theologians such speculations in cosmology speak directly to long-established beliefs about creation¹¹.

Most physicists refer to the Big Bang as a «singularity», that is, an ultimate boundary or edge, a «state of infinite density» where spacetime has ceased. Thus it represents an outer limit of what we can know about the universe. If all physical theories are formulated in the context of space and time, it would not be possible to speculate, at least in the natural sciences, about conditions before or beyond these categories. Nevertheless, during the last twenty years, precisely such speculation has intrigued several cosmologists¹². Some of them now offer theories which propose to account for the Big Bang itself as a fluctuation of a primal vacuum. Just as sub-atomic particles are thought to emerge spontaneously in vacuums in laborat-

¹⁰ Stephen HAWKING and Roger PENROSE, *The Nature of Space and Time* (Princeton: Princeton University Press, 1996), p. 71.

¹¹ The literature on this subject is enormous. Among many authors who offer a survey of these recent variations in Big Bang cosmology and comment on their philosophical and theological implications see: William E. CARROLL, «Big Bang Cosmology, Quantum Tunneling from Nothing, and Creation»: *Laval théologique et philosophique* XLIV (1988) 59-75; Mariano ARTIGAS, «Física y creación: el origen del universo»: *Scripta Theologica* XXIX (1987) 347-373; E. MCMULLIN, «Natural Science and Belief in a Creator: Historical Notes»; W. R. STOEGER, «Contemporary Cosmology and Its Implications for the Science-Religion Dialogue»; T. PETERS, «On Creating the Cosmos»; J. POLKINGHORNE, «The Quantum World»; R. J. RUSSELL, «Quantum Physics in Philosophical and Theological Perspective»; and C. J. ISHAM, «Creation of the Universe as a Quantum Process», in *Physics, Philosophy, and Theology: A Common Quest for Understanding*, edited by Robert John Russell, William R. Stoeger S. I., and George V. Coyne S. I. (Vatican City: Vatican Observatory Publications, 1988), pp. 49-79, 219-247, 273-296, 333-342, 343-374, 375-408; William Lane CRAIG and Quentin SMITH, *Theism, Atheism and Big Bang Cosmology* (Oxford: Oxford University Press, 1993); C. J. ISHAM, «Quantum Theories of the Creation of the Universe»; and Robert John RUSSELL, «Finite Creation Without a Beginning: The Doctrine of Creation in Relation to Big Bang and Quantum Cosmologies», in *Quantum Cosmology and the Laws of Nature*, edited by Robert John Russell, Nancey Murphy, and C. J. Isham (Vatican City: Vatican Observatory Publications, 1993), pp. 49-89, 293-329; Ernan MCMULLIN, «Indifference Principle and Anthropic Principle in Cosmology»: *Studies in History and Philosophy of Science* XXIX (1993) 359-389; Juan José SANGUINETI, *El origen del Universo: La cosmología en busca de la filosofía* (Buenos Aires: Editorial de la Universidad Católica Argentina, 1994), and «La creazione nella cosmologia contemporanea»: *Acta Philosophica* IV (1995) 285-313; Joseph ŻYCIŃSKI, «Metaphysics and Epistemology in Stephen Hawking's Theory of the Creation of the Universe»: *Zygon*, XXXI (1996) 269-284.

¹² As a historian of science I am not competent to judge the specific scientific claims in these various speculations. I do wish to examine the philosophical and theological claims so frequently associated with these speculations and to show how the history of mediaeval philosophy, theology, and science is especially useful in such an examination.

ories, so the whole universe may be the result of a similar process¹³. Professor Alexander Vilenkin of Tufts University has developed a variation of an inflationary model of the expanding universe which accounts for the birth of the universe «by quantum tunneling from nothing». «Nothing», for Vilenkin, is a «state with no classical space-time [...] the realm of unrestrained quantum gravity; it is a rather bizarre state in which all our basic notions of space, time, energy, entropy, etc., lose their meaning»¹⁴.

Vilenkin and Alan Guth (the original proponent of the «inflationary model»)¹⁵ base their variations of Big Bang theory on extrapolations from high energy physics. The four fundamental forces (the strong, the weak, gravity, and electro-magnetic) and the elementary sub-atomic particles (leptons and quarks) are «low temperature phenomena». At the temperatures estimated at the time of the Big Bang itself, temperatures around 10^{32} degrees Kelvin¹⁶, all the forces of nature are thought to exist in a single, undifferentiated superforce, and all the now disparate sub-atomic particles had not yet acquired distinct identities. According to the «inflationary model», there was a rapid «supercooling» of the universe when it was about 10^{-35} second old which produced a tremendous amount of energy, some of which condensed into matter¹⁷.

¹³ One of the early proponents of this view was Edward Tryon of the City University of New York. He argued that the Big Bang could be understood as «quantum tunneling from nothing». *Nature* 246, no. 14 (14 December 1973), p. 396.

¹⁴ «Birth of Inflationary Universes»: *Physical Review D* 27:12 (1983) 2851. Other essays by Vilenkin: «Quantum Cosmology and the Initial State of the Universe»: *Physical Review D* 37 (1988) 888-897, and «Approaches to Quantum Cosmology»: *Physical Review D* 50 (1994) 2581-2594.

¹⁵ Alan Guth has recently published an account of his development of the theory of an inflationary universe: *The Inflationary Universe: The Quest for a New Theory of Cosmic Origins* (Reading, MA: Addison Wesley, 1997). His seminal article on inflation is: «Inflationary Universe: A Possible Solution to the Horizon and Flatness Problem»: *Physical Review D* 23 (1981) 347-356.

¹⁶ As a result of evidence from background microwave radiation, physicists estimate the present temperature of the universe to be 2.7 degrees Kelvin.

¹⁷ Andrei Linde, now at Stanford, has proposed a fascinating variation of Guth's inflationary theory, dubbed «chaotic inflation». In Linde's theory, our universe began as a bubble that ballooned out of the spacetime of a pre-existing universe. Timothy Ferris describes it this way: «The maternal spacetime is chaotic in that it contains scalar fields of all possible parameters; one scalar field — an unlikely but possible one — emerged as the driving force of the inflationary event that launched the expansion of our universe» (*The Whole Shebang: A State of the Universe[s] Report* [New York: Simon and Schuster, 1997], p. 259). Linde suggests that we «live in a low-energy bubble in an incredibly huge and complicated universe, parts of which are bubbles something like ours, while other parts are only now passing through their big bang baptisms, and still more are continuing to balloon in ghostly vacuum states at velocities far greater than light» [Quoted in FERRIS, *op. cit.*, p. 262.] For Linde, it makes little sense to search for some «original bubble»: each bubble owes its birth to another bubble. The «evolution of the universe as a whole has no end, and it may have no beginning», according to Linde [Quoted in FERRIS, *op. cit.*, p. 263]. The title of Linde's November 1994 article in *Scientific American* is suggestive: «The Self-Reproducing Inflationary Universe». See also, Andrei Linde, *Inflation and Quantum Cosmology* (New York: Academic Press, 1990).

Another physicist who imagines a whole chain of universes within universes is Lee Smolin, who has developed a theory of «cosmological natural selection», according to which «our universe forms part of an endless chain of self-reproducing universes whose physical laws evolve as they are passed along».

For those cosmologists unwilling to accept an unexplained Big Bang, or an explanation which seemed to them to require a supernatural agent, the variation of the Big Bang theory proposed by Vilenkin and Guth was welcome. Their account of the early history of the universe offers a resolution to what has been a troublesome problem for any one who proposed that the universe could emerge from some kind of cosmic nothingness. It is a problem which concerns the superabundance of matter to anti-matter in the universe. Laboratory experiments, ever since the discovery of the positron (the anti-electron) in 1932, seem to indicate that high energy collisions in particle accelerators produce equal quantities of particles and anti-particles. Yet, in our immediate world we almost never encounter anti-particles. If the universe contains an overwhelming preponderance of matter to anti-matter, was it always thus? If not, that is, if there were an original equilibrium state, how did the present asymmetry come about?¹⁸

The explanation of the «inflationary universe» proposed by Guth and Vilenkin offers the following chronology: first there is a primal Big Bang, a «quantum tunneling from nothing», and then, a brief phase of «runaway exponential expansion», and the energy accumulated at the termination of this very rapid expansion would be converted into matter and radiation.

Are we on the verge of a scientific explanation of the very origin of the universe? The contention of several proponents of the new theories is that the laws of physics are themselves sufficient to account for the origin and existence of the universe. If this be true, then, in a sense, we live in a universe which needs no explanation beyond itself, a universe which has sprung into existence spontaneously from a cosmic nothingness. Heinz Pagels, writing a few years ago, claimed that «When historians of science look back on the 1970s and 1980s they will report that for the first time scientists constructed rational mathematical models based on the laws of physics which described the creation of the universe out of nothing. And that will mark the beginning of a new outlook on the creation of existence». Pagels is confident that «from microcosm to macrocosm, from its origin to its end, the universe is described by physical laws comprehensible to the human mind»¹⁹.

For Smolin, «the laws of physics in this universe (or universes) are less like commandments from God and more like the zoning regulations promulgated by some fractious city council, ever susceptible to amendment and compromise» (Dennis OVERBYE, «The Cosmos According to Darwin»: *The New York Times Magazine* [July 13, 1997], p. 26). Smolin thinks that the universe is like a city, «an endless negotiation, an endless construction of the new out of the old [...] No one made the city. There is no city-maker, as there is a clockmaker. If a city can make itself without a maker, why can the same not be true of the universe?» Each black hole, just like the black hole in which the Big Bang occurred, begets a new universe which expands, evolves, and eventually creates new black holes which spawn new universes: «[...] over many cycles a kind of Darwinian pressure would encourage the formation of universes whose physics favored black holes, since universes that did not make black holes would have no progeny» [OVERBYE, *cited art.*, p. 27]. See, Lee SMOLIN, *The Life of the Cosmos* (New York: Oxford University Press, 1997).

¹⁸ A good summary of the problems of accounting for such an asymmetry —especially as it concerns perturbations in the very early history of the universe— can be found in M. S. LONGAIR, «The Universe —present, past, and future»: *Contemporary Physics* XXVII (1986) 325-343.

¹⁹ *Perfect Symmetry: The Search for the Beginning of Time* (London: Michael Joseph, Ltd., 1985), pp. 349 and 17.

Paul Davies, the British physicist who has written extensively on physics, cosmology, and their philosophical and theological implications, thinks that the theory of an inflationary universe accounts for the emergence «out of nothingness» of both fundamental particles and spacetime itself «as the result of a causeless quantum transition». In this remarkable scenario, the entire universe simply comes out of nowhere, completely in accordance with the laws of physics, and creates along the way all the matter and energy needed to build the universe as we now see it²⁰.

Although recently Davies has become less enthusiastic about the promises of the new physics, a decade ago he wrote the following:

«For the first time, a unified description of all creation could be within our grasp. No scientific problem is more fundamental or more daunting than the puzzle of how the universe came into being. Could this have happened without any supernatural input? Quantum physics seems to provide a loophole to the age-old assumption that “you can’t get something from nothing”. Physicists are now talking about the “self-creating universe”: a cosmos that erupts into existence spontaneously, much as a sub-nuclear particle sometimes pops out of nowhere in certain high energy processes. The question of whether the details of this theory are right or wrong is not so very important. What matters is that it is now possible to conceive of a scientific explanation for all of creation. Has modern physics abolished God altogether [...]?»²¹.

In an even more radical vein, the philosopher Quentin Smith writes that «there is sufficient evidence to warrant the conclusion that the universe [...] began to exist without being caused to do so»²². The title of his essay is «The Uncaused Beginning of the Universe», and his conclusion is revealing: «[...] the fact of the matter is that the most reasonable belief is that we came from nothing, by nothing and for nothing»²³. Elsewhere Smith writes that if Big Bang cosmology is true «our universe exists without cause or without explanation [...] [This world] exists non necessarily, improbably, and causelessly. It exists *for absolutely no reason at all*»²⁴.

²⁰ *God and the New Physics* (New York: Simon and Schuster, 1983), p. 215. When Davies speaks of a «causeless quantum transition», he is using the term «cause» to refer to a temporal succession of predictable events. There is a great deal of confusion in the philosophical interpretation of quantum mechanics, especially with respect to the meaning of Heisenberg’s «relation of uncertainty». It is one thing to affirm that we are not able to provide a precise mathematical measure of both the velocity and the position of a sub-atomic particle; it is quite another to deny the objective reality of the particle or to contend that there is a realm of «causeless» effects. We might not be able to predict certain events. This does mean that these events have no cause.

²¹ *Ibid.*, p. viii.

²² William Lane CRAIG and Quentin SMITH, *op. cit.*, p. 109. See note 11.

²³ *Ibid.*, p. 135. A particularly good example of the persisting confusion about the roles of science, metaphysics, and theology in understanding the universe and its origins is an essay by P. W. Atkins, distinguished physical chemist at Oxford University. Convinced that all human knowledge is reducible to the explanatory categories of the natural sciences, Atkins thinks that the domain of scientific discourse is truly limitless. Accordingly, he says that it is the task of science «to account for the emergence of everything from absolutely nothing. Not almost nothing, not a subatomic dust-like speck, but absolutely nothing. Nothing at all. Not even empty space». P. W. ATKINS, «The Limitless Power of Science», in *Nature’s Imagination: The Frontiers of Scientific Vision*, edited by John Cornwell (Oxford: Oxford University Press, 1995), p. 131. For a criticism of this essay, see William E. CARROLL, «Reductionism and the Conflict Between Science and Religion»: *The Allen Review* XV (1996) 19-22.

²⁴ *Ibid.*, p. 217. Italics are in the original.

There is another major trend in the application of quantum mechanics to cosmology—different from the inflationary universe and the quantum tunneling from nothing described by Vilenkin—but no less significant in the claims it makes, or are made for it, concerning the answers to ultimate questions about the universe. This is the view made famous by Stephen Hawking in *A Brief History of Time* (1988). Hawking argues that quantum mechanics shows us that the classical picture of a «well-defined spacetime arises as a limiting case of the quantum perspective»²⁵. Time is less fundamental than space and, as a consequence, spacetime cannot have a singular, initial boundary. There is no singularity, no initial boundary at all; the universe has no beginning! Even though unbounded, the universe is finite. Here is how Hawking sets forth his view:

«The quantum theory of gravity has opened up a new possibility, in which there would be no boundary to space-time and so there would be no need to specify the behavior at the boundary. One could say: “The boundary condition of the universe is that it has no boundary”. The universe would be completely self-contained and not affected by anything outside itself. It would neither be created nor destroyed. It would just BE»²⁶.

Hawking thinks that the inflationary model of the universe cannot explain the present state of the universe. He is troubled by two questions which he does not think the traditional theory of the Big Bang can answer: 1) why is the universe so homogenous and isotropic on a large scale, whereas there are «local irregularities» such as galaxies and stars; 2) why is the universe so close to the dividing line between collapsing again and expanding indefinitely?²⁷ The appeal to an initial singularity is, for Hawking, an admission of defeat: «If the laws of physics could break down at the beginning of the universe, why couldn't they break down anywhere?»²⁸. To admit a singularity is to deny a universal predictability to physics, and, hence ultimately, to reject the competency of science to understand the universe. He claims that the «no-boundary proposal can explain all the structure of the universe, including little inhomogeneities like ourselves»²⁹. The combination of quantum mechanics with general relativity results in the possibility «that space and

²⁵ For a very good account of Hawking's analysis, actually the Hartle/Hawking analysis, see Robert John RUSSELL, «Finite Creation Without a Beginning...», in *Quantum Cosmology and the Laws of Nature*, *op. cit.*, pp. 293-329. J. HARTLE-S. HAWKING, «Wave Function of the Universe»: *Physical Review D* 28 (1983) 2960-2975; S. HAWKING, «The Boundary Condition of the Universe», in *Astrophysical Cosmology*, edited by H. A. Brück, G. V. Coyne, M. S. Longair (Vatican City: Pontifical Academy of Science, 1982), pp. 563-572; S. HAWKING, «The Quantum State of the Universe»: *Nuclear Physics B* 239 (1984) 257-276.

²⁶ Hawking, *A Brief History of Time*, *op. cit.*, p. 136. The two «most remarkable features that I have learned in my research on space and time [are]: 1) that gravity curls up spacetime so that it has a beginning and an end; 2) that there is a deep connection between gravity and thermodynamics that arise[s] because gravity itself determines the topology of the manifold on which it acts». Hawking in HAWKING and PENROSE (1996), *op. cit.*, p. 103.

²⁷ HAWKING and PENROSE (1996), *op. cit.*, p. 89.

²⁸ *Ibid.*, p. 76.

²⁹ *Ibid.*, p. 96. Hawking admits that quantum general relativity is not able to embrace all of spacetime in its account: that there is, in principle, an incompleteness in its explanation (p. 103).

time together might form a finite, four-dimensional space without singularities or boundaries, like the surface of the earth but with more dimensions»³⁰.

Hawking is not shy about drawing a theological conclusion from his cosmological speculations. If the universe had no beginning, there is nothing whatsoever for God to do —except to chose the laws of physics. Physics, were it to discover a unified theory, will allow us to know «the mind of God». Here again are Hawking's words:

«So long as the universe had a beginning, we could suppose it had a creator. But if the universe is really completely self-contained, having no boundary or edge, it would have neither beginning nor end: it would simply be. What place, then, for a creator?»³¹.

Carl Sagan, in his introduction to *A Brief History of Time*, is also not afraid to draw theological conclusions, although he does alter the implications of Hawking's work:

«This is also a book about God [...] or perhaps about the absence of God. The word God fills these pages. Hawking embarks on a quest to answer Einstein's famous question about whether God had any choice in creating the universe. Hawking is attempting, as he explicitly states, to understand the mind of God. And this makes all the more unexpected the conclusion of the effort, at least so far: a universe with no edge in space, no beginning or end in time, and nothing for a Creator to do»³².

One of the more prolific writers on current cosmology is John Barrow, professor of astronomy at the University of Sussex in England. In *The Origins of the Universe* (1994), Barrow observes that the no-boundary condition of Hawking's quantum cosmology has become increasingly attractive because it «avoids the

³⁰ *A Brief History of Time*, *op. cit.*, p. 173. The Hartle/Hawking model involves complicated speculation about quantum gravity. C. J. Isham's «Creation of the Universe as a Quantum Process», *op. cit.*, offers the most detailed systematic summary of this position. Robert Russell writes that the two crucial points to keep in mind are: 1) this model succeeds in describing a universe with a finite past but no initial singularity, and thus «changes the scientific mode of discussion about the origination of the universe»; 2) «time arise phenomenologically in this model; it is not a given, external parameter which describes the evolution of the universe» as in the standard Big Bang model. See RUSSELL, «Finite Creation Without a Beginning», *op. cit.*, pp. 311-312. Even within the Hartle/Hawking model it is very difficult to get a handle on the nature of «quantum time» and its relation to the conception of time found in relativity theory. It is not quite clear —indeed, this is an understatement— what one means by the notion of a «finite past» when one is dealing with quantum gravity, especially since the very notion of quantum gravity has not yet been fully worked out. See RUSSELL, *op. cit.*, p. 318.

³¹ *Ibid.*, p. 141. C. J. Isham thinks that the Hartle/Hawking model is philosophically superior to the standard Big Bang model with an initial singularity. «[T]hese [quantum fluctuation] theories are prone to predict, not a single creation/seed-point, but rather an infinite number of them [...]». «There is simply no way of distinguishing any particular instant of time» at which the universe would spontaneously appear. Whereas for Aquinas reason alone is unable to decide whether or not the universe has an absolute temporal beginning —or better, since he believes that there is such a beginning—, it is hidden from the view of human reason, in the Hartle/Hawking model an absolute beginning simply does not exist. Willem Drees agrees with Isham and thinks that, since theology is not really wedded to historical origination but only ontological origination, the Hartle/Hawking model is more compatible with the Christian doctrine of creation *ex nihilo*. See W. DREES, *Beyond the Big Bang: Quantum Cosmologies and God* (LaSalle, IL: Open Court: 1990), especially pp. 70-71.

³² *Ibid.*, p. x.

necessity for [...] a cataclysmic beginning». Barrow thinks that the traditional Big Bang picture, with its initial singularity of infinite density «is, strictly speaking [...], creation out of absolutely nothing»³³.

It is interesting that some Christians rushed to embrace Big Bang cosmology because they saw it as scientific confirmation of the Genesis story of creation³⁴. Accordingly, we may understand the particular attraction of some to current variations in Big Bang cosmology which purport either to account for the initial singularity in terms of quantum tunneling or to deny the existence of an initial boundary to the universe. In either case, so it might seem, the role of a creator is superfluous³⁵. As we shall see, to use Big Bang cosmology either to affirm creation or to deny it is an example of misunderstandings of both cosmology and creation.

The universe described by Sagan, Hawking, and others —the fruit so it seems of contemporary cosmology— is a self-contained universe, exhaustively understood in terms of the laws of physics. In such a universe there would seem to be little if any need for the God of Jewish, Christian, or Muslim revelation. The traditional doctrine of creation seems obsolete in the face of the recent advances of modern science. For some the notion of a Creator represent an intellectual artifact from a less enlightened age.

Too often contemporary discussions about the theological and philosophical implications of Big Bang cosmology, as that cosmology has been refined, suffer from an ignorance of the history of science, and, with respect to the theories which claim to involve the origin of the universe, these recent discussions reveal an ignorance of the sophisticated analyses of the natural sciences and of creation which took place in the Middle Ages. The reception of Aristotelian science in Muslim, Jewish, and Christian intellectual circles in the Middle Ages provided the occasion for a wide-ranging discussion of the relationship between theology and the natural sciences³⁶. Aquinas' understanding of creation —and, in particular, the distinctions he draws among theology, metaphysics, and natural philosophy— can continue to serve as an anchor of intelligibility in a contemporary sea of speculative theories.

It seemed to many of Aquinas' contemporaries that there was a fundamental incompatibility between the claim of ancient physics that something cannot come from absolutely nothing and the affirmation of Christian faith that God did produce everything from nothing. Furthermore, for the ancients, since something must come from something, there must always be something, i.e., the universe must be eternal. Despite the claims of some contemporary theorists that, properly speaking, we can get something from nothing, those theories of the Big Bang which employ insights from particle physics concerning vacuum fluctuations are consist-

³³ John BARROW, *The Origin of the Universe* (New York: Basic Books, 1994), p. 113.

³⁴ In fact, in the 1950s and 1960s Soviet cosmologists were forbidden to teach the theory since it was considered to be theistic science.

³⁵ For a discussion of these reactions, see CARROLL, «Big Bang Cosmology, Quantum Tunneling from Nothing, and Creation», *op. cit.*, pp. 64-67.

³⁶ See Herbert A. DAVIDSON, *Proofs for Eternity, Creation and the Existence of God in Medieval Islamic and Jewish Philosophy* (New York: Oxford University Press, 1987).

ent with the ancient principle that you cannot get something from nothing. The «vacuum» of modern particle physics, whose «fluctuation» supposedly brings our universe into existence, is not absolutely nothing. It is only no thing like our present universe, but it is still something. How else could «it» fluctuate? Thus, we need to recognize that frequently the «nothing» discussed by contemporary cosmologists is not absolutely nothing. Yet, it is this latter sense of nothing which is crucial to the traditional doctrine of creation out of nothing.

Joseph Życiński has described well the confusion between metaphysical nothingness and the concept of a vacuum in contemporary physics. Even in the absence of particles, «physical fields do not disappear, and their properties still can be characterized in the abstract language of mathematics»³⁷. In attempting to describe the significance of Hawking's discussion of creation, C. J. Isham claims that we can identify the mathematical concept of any empty set with the absolute nothing in the traditional understanding of creation out of nothing: «The initial space from which the universe «emerged» can be defined to be that part of the boundary of 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»!»³⁸.

³⁷ Joseph ŻYCINSKI, «Metaphysics and Epistemology in Stephen Hawking's Theory of the Creation of the Universe», *op. cit.*, p. 272. See note 11.

³⁸ C. J. ISHAM, «Creation of the Universe as a Quantum Process», *op. cit.*, p. 401. See note 11. Alan Guth (*The Inflationary Universe, op. cit.*) suggests that there is a way to avoid the dilemma of claiming that science can account for getting something from absolutely nothing. He thinks that once we recognize that «the energy stored in the gravitational field [a kind of gravitational potential energy] is represented by a negative number [...] [t]he immense energy that we observe in the form of matter can be canceled by a negative contribution of equal magnitude, coming from the gravitational field. There is no limit to the magnitude of energy in the gravitational field, and hence no limit to the amount of matter/energy that it can cancel». In a glossary, Guth describes «gravitational potential energy» in the following way. «When we lift a weight from the floor to a tabletop, we clearly put energy into it. The energy is not lost, however, because we can retrieve it by allowing the weight to fall back to the floor. While the weight is on the table, we say that the energy is stored as gravitational potential energy. The energy is stored in the gravitational field» (p. 334). At each point in space, the gravitational field «is defined as the force that would be experienced by a standard mass, if the mass were positioned at that point» (p. 333). Guth concludes: «Given this peculiar property of gravity, a scientific description of the creation of the universe is not precluded by the conservation of energy. Other conservation laws also need to be considered, in particular the conservation of a quantity called *baryon number* [...] But the conclusion will not be changed: The universe could have evolved from absolutely nothing in a manner consistent with all known conservation laws. While no detailed scientific theory of creation is known, the possibility of developing such a theory now appears open» (p. 12). Timothy Ferris refers to the same argument Guth sets forth. Ferris identifies the principle that you can't get something from nothing with the «law of the conservation of energy —that a zero-energy system to which no energy is added must remain in a zero-energy state. As the physicist Edward Tryon, then at Columbia, proposed in the 1970s, gravitation is a purely attractive force and so should be entered on the negative side of the cosmic energy ledger. Sum it against all the matter and energy in the universe, and the result, remarkably is zero. If this analysis is correct —admittedly a big if— genesis isn't a matter of getting something from nothing but of getting one zero-energy system from another zero-energy system» (Timothy FERRIS, *op. cit.*, p. 248). It seems that Guth and others confuse mathematical formalism with physical reality and fundamentally misunderstand the sense of «nothing» in the

Życiński correctly observes that the empty mathematical set, to which Isham refers, is subject to the principles of logic and to the laws of quantum cosmology and, as such, cannot be identified with absolute nothing. The various accounts of an initial singularity embrace physical and mathematical principles necessary to account for the emergence of the universe³⁹. «The alleged nothing [discussed in contemporary cosmology by Hawking and others] 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»⁴⁰. Thus, the nothing of contemporary cosmological theories turns out to be really something.

For many thinkers in the Middle Ages, the eternal universe of ancient Greek science seemed to be incompatible with a universe created out of nothing. The eternal universe left no room for nothing, allowed no absence, so to speak, in which the Christian God could create. At least so some Christians thought, and they urged that ancient science, especially in the person of Aristotle, its leading proponent, be banned, since it contradicted the truths of revelation⁴¹. Aquinas' contribution to the Mediaeval debate about creation and the eternity of the world speaks directly to discourse on cosmology and creation in our own day.

The key to Aquinas' analysis is the distinction he draws between creation and change, or as he often said: *creatio non est mutatio*. The natural sciences, whether Aristotelian or contemporary, have as their subject the world of changing things: from subatomic particles to acorns to galaxies. Whenever there is a change there must be something which changes. The ancients are right: from nothing, nothing comes; that is, if the verb «to come» means a change. All change requires some underlying material reality.

Creation, on the other hand, is the radical causing of the whole reality of whatever exists. To cause completely something to exist is not to produce a change in

doctrine creation out of nothing. Życiński's analysis of Hawking holds as well for Guth.

³⁹ Or, at the very least, as Życiński notes, we need some kind of cosmic logos which allows us to conclude that the boundary state is truly a boundary state, not preceded by any physical phenomena. In fact, «[w]hat was too easily identified with metaphysical nothingness seems to be a sophisticated reality of the logos, described by Hellenic philosophers of the Neoplatonic tradition» (ŻYCINSKI, *op. cit.*, pp. 277-278).

⁴⁰ *Ibid.*, p. 279. Robert Russell makes a similar point: «In the Hartle/Hawking case, the arguments tend to revolve around the idea that, although a previously existing spacetime of some sort is not proposed, a *pre-existing set of laws of nature* are presupposed to exist. But such laws would be included in what the traditional doctrine [of creation] considers as falling within God's creation and not something external to, and co-eternal with, God. Hence even the Hartle/Hawking model does not assume the creation of the universe out of *oukonic* [from *ouk on*] non-being» (RUSSELL, «Finite Creation Without a Beginning [...]», *op. cit.*, p. 321. William Stoeger makes the point that one ought not to view the «laws of nature» as having an ontological standing of their own—they may simply describe the way nature acts as distinct from prescribing nature's behavior. See William R. STOEGER, «Contemporary Physics and the Ontological Status of the Laws of Nature», in *Quantum Cosmology and the Laws of Nature*, *op. cit.*, pp. 209-234.

⁴¹ Luca BIANCHI, *L'errore di Aristotele: La polemica contro l'eternità del mondo nel XIII secolo* (Firenze: L. Olschki, 1984); Richard C. DALES, *Medieval Discussions of the Eternity of the World* (Leiden: Brill, 1990).

something; to create, thus, is not to work on or with some already existing material. If there were a prior something which was used in the act of producing a new thing then the agent doing the producing would not be the *complete* cause of the new thing. But such a complete causing is precisely what creation is. Thus, to create is to give existence, and all things depend upon God for the fact that they are. God does not take nothing and make something out of «it». Rather, any thing left entirely to itself, separated from the cause of its existence, would be absolutely nothing. Creation is not exclusively some distant event; it is the continual, complete causing of the existence of whatever is.

Many theologians and philosophers find considerable significance in a distinction between an original act of creation and God's continuing causal agency. But for Aquinas, there is really no difference between creation and what is called conservation; conservation is simply the continuation of creation. In Book I of his *Writings on the Sentences of Peter Lombard*, Aquinas remarks that the relation of a house to its builder is very different from the relation of a creature to the Creator. Once the coming-to-be of the house is complete, the house ceases to have any relation of dependence upon its builder; the builder could die, and the house would continue to stand. But the case is quite otherwise with the creature *qua* creature. The Creator's causality must be continual, and of the same kind, all throughout the creature's existence. All things would fall into non-being, Aquinas says, unless God's omnipotence supported them. «Whence, it is necessary that His [God's] operation, by which He gives being, not be broken off, but be continual»⁴². In *De potentia Dei*, Aquinas notes that the operation by which God creates and conserves is the same⁴³.

Thomas Aquinas is particularly insightful in distinguishing between the origin of the universe and the beginning of the universe. Beginning refers to a temporal event, and an absolute beginning of the universe would be an event which is coincident with the beginning of time. Creation is an account of the origin, or source of existence, of the universe, and, as such, Aquinas thinks that creation can be demonstrated in the science of metaphysics. In his *Writings on the Sentences*, completed in Paris in the 1250s, Aquinas claims: «Not only does faith hold that there is creation, but reason also demonstrates it»⁴⁴. The development by Aquinas

⁴² *In I Sent.*, dist. 37, q. 1, a. 1, *resp.*

⁴³ «It ought to be said that God does not produce things into being by one operation and conserve them in being by another. The being [*esse*] of permanent things is not divisible, except accidentally as it is subject to some motion; being, however, exists in an instant. Whence the operation of God does not differ according as it makes the beginning of being and as it makes the continuation of being» (*De potentia Dei*, q. 5, a. 1, ad. 2). The reason given here for the fact that creation and conservation are the same is not that in God all things are one in His perfect simplicity, but that the effect of God's causality, the being of the creature, is the same effect all throughout the existence of the creature.

⁴⁴ We find Aquinas' claim that reason demonstrates creation in several places, two of which are of particular importance: *In II Sent.* dist. 1, q. 1, aa. 1 and 2; *De potentia Dei*, q. 3, a. 5. In this latter text, Aquinas combines two separate arguments from Aristotle: the first is an argument from participation taken from *Metaphysics* II 1: 993 b 23-27; the second, the argument from motion to a first unmoved mover, taken from books seven and eight of the *Physics*. By means of the second argument Aquinas

of an understanding of creation *ex nihilo*, and, in particular, his understanding of the possibility of an eternal, created universe, offers one of the best examples of his account of the relationship between faith and reason. In fact, his magisterial treatment of the doctrine of creation, which we can find in three other places⁴⁵, is one of the enduring accomplishments of the thirteenth century. In the appendix to this essay I have provided the text of Aquinas' extended definition of creation *ex nihilo* as found in his *Writings on the Sentences*.

Contrary to the claims of Averroes⁴⁶, for example, Aquinas thought that a world created *ex nihilo* (whether that world be eternal or temporally finite) was susceptible to scientific understanding. Of its own nature—that is, left completely to itself—the creature is non-being rather than being, and it must be caused by God continuously lest it return to the non-being which it properly is. It is true to say that the creature is literally nothing without the creative causality of God. Nevertheless, we must remember that the being of creatures, far from being an accident, is the ultimate perfection or actuality of the creature⁴⁷. Most profoundly, in the depths of any creature is its being; a creature is nothing so much as its own being. The creature, thus, far from being an insubstantial, quasi-nothing, is a real something, existing on its own. In giving being to the creature, God does not merely make the creature to be an extension of Himself; rather He gives the creature an inherent stability in being, i.e., a tendency to exist. God gives being in such a way that the tendency of the given being is not to lapse into non-being but precisely to remain in being⁴⁸. Creation so understood does not destroy the autonomy of that

proves the existence of a most perfect and true being; by means of the first argument he proves that all other things participate in the most perfect and true being.

⁴⁵ *Summa contra Gentiles* II cc. 6-38; *De potentia Dei*, q. 3; and *Summa theologiae* I qq. 44-46.

⁴⁶ Even though Averroes claimed that an eternal, created universe was indeed probable, he rejected the idea of creation out of nothing in its strict sense. He thought that creation consisted in God's eternally converting potentialities into actually existing things. For Averroes, the doctrine of creation out of nothing contradicted the existence of a true natural causality in the universe: «[al-Ghazali's] assertion [in defense of creation out of nothing] [...] that life can proceed from the lifeless and knowledge from what does not possess knowledge, and that the dignity of the First consists only in its being the principle of the universe, is false. For if life could proceed from the lifeless, then the existent might proceed from the non-existent, and then anything whatever might proceed from anything whatever, and there would be no congruity between causes and effects, either in the genus predicated analogically or in the species» (*Tahāfut al-Tahāfut [The Incoherence of the Incoherence]*, trans. by Simon Van den Bergh [London: Luzac, 1954], p. 452).

⁴⁷ *In I Sent.*, dist. 8, q. 1, a. 3.

⁴⁸ God so constitutes the being of creatures that they tend to exist and not to fall into nothingness: «The natures of creatures manifest that no creatures are degenerating into nothing, either because they are immaterial beings, in which there is no potency to non-being, or because they are material beings, and these remain in existence, at least in their matter, which is incorruptible» (*Summa theologiae* I q. 104, a. 4, sol. See also *De potentia Dei*, q. 5, a. 4).

On this point it is helpful to compare the doctrine of St. Bonaventure who, like Aquinas, does not hold that created beings have a tendency to non-existence, but who, unlike Aquinas, thinks that since creatures are *temporal* they need a maintenance in being, called conservation, that is different from their being created in the first place. It is true for both Aquinas and Bonaventure that creatures will cease to exist if God should cease to cause their existence. For Aquinas, however, God gives being,

which is created: created beings can and do function as real secondary causes, causes which can be discovered in the natural sciences.

The relationship between divine action and the world—both with respect to the natural sciences and human freedom—continues to be a topic of extended commentary and debate⁴⁹. Some views refer to a divine withdrawal from the world so as to leave room (a metaphysical space) for the action of creatures. Thus, God is said to allow or to permit human freedom. Other views embrace a process theology which denies God's immutability and His omnipotence (as well as His knowledge of the future) so that God is said to be evolving or changing along with the universe and everything in it. For Aquinas, such views fail to do justice either to God or to creation. Creatures are and are what they are (including those which are free) precisely because God is present to them as cause. Were God to withdraw, all that exists would cease to be. Real causality in nature—that which Averroes and Maimonides recognized must be protected against the views of certain of the kalam theologians—is not challenged by divine omnipotence or divine omniscience. Creaturely freedom and the integrity of nature, in general, are guaranteed by God's creative causality, i.e., by God's intimate presence in all that He creates. As Simon Tugwell aptly puts it: "The fact that things exist and act in their own right is the most telling indication that God is existing and acting in them"⁵⁰. Aquinas provides the following analysis in the *Summa theologiae*:

and no other act is required in order to keep creatures in existence. For Bonaventure, on the other hand, God must perform two different acts: He gives being initially and, since the creature cannot naturally maintain its own existence, He conserves the creature in existence (BONAVENTURE, *In II Sent.*, dist. 37, a. 1, q. 2, sol.). In other words, according to Bonaventure, if we look at the natural principles of a creature, form and matter, the creature is not mutable into absolute non-being. If, however, we look at the fact that creatures are made out of nothing, we find an inherent emptiness (*vanitas*), instability (*instabilitas*), and mutability (*vertibilitas*). Hence, by nature creatures are mutable into non-being, but by God's grace they are conserved in being (BONAVENTURE, *In I Sent.*, dist. 8, part 1, a. 2, q. 2, sol. and ad 7-8.).

An illustration of the fact that in Aquinas' doctrine being belongs essentially to the creature can be found in *De potentia Dei* (q. 5, a. 3), where he asks whether God can return the creature to nothing. When Aquinas answers this question he rejects the view of Avicenna, who had argued that the essence of the creature is of itself a pure possibility toward either being or non-being. Aquinas agrees with Averroes in thinking that some creatures, such as immaterial substances and heavenly bodies, have an inherent necessity for existing, for there is in them no possibility for corruption. Aquinas, however, carries Averroes' point further, and argues that no creature, whether material or immaterial, has any sort of potency for non-being: "[...] in the whole of created nature, there is no potency through which it is possible for something to tend into nothing" (*De potentia Dei*, q. 5, a. 3, sol.). It is true that material bodies tend to corrupt, but matter itself, prime matter, is incorruptible. The whole of the universe, considered in itself, has its own being and tends to continue in being. Of itself, it has no potency, or tendency, to non-being. However true it may be to say that the creature would be absolutely nothing without the creative causality of God, still, the creature really, and even essentially, has its very own being. Thus, since creatures do have their own being, they are able to be true, autonomous causes.

⁴⁹ See Robert John RUSSELL, Nancey MURPHY, and Arthur R. PEACOCKE. *Chaos and Complexity: Scientific Perspectives on Divine Action* (Vatican City: Vatican Observatory Publications, 1995).

⁵⁰ Simon TUGWELL. *Albert and Aquinas: Selected Writings* (New York: The Paulist Press, 1988), p. 213.

«Some have understood God to work in every agent in such a way that no created power has any effect in things, but that God alone is the ultimate cause of everything wrought; for instance, that it is not fire that gives heat, but God in the fire, and so forth. But this is impossible. First, because the order of cause and effect would be taken away from created things, and this would imply lack of power in the Creator, for it is due to the power of the cause, that it bestows active power on its effect. Secondly, because the active powers which are seen to exist in things, would be bestowed on things to no purpose, if these wrought nothing through them. Indeed, all things created would seem, in a way, to be purposeless, if they lacked an operation proper to them, since the purpose of everything is its operation [...] We must therefore understand that God works in things in such a manner that things have their proper operation [...] Thus then does God work in every worker, according to these three things. First as an end. For since every operation is for the sake of some good, real or apparent; and nothing is good either really or apparently, except in as far as it participates in a likeness to the supreme good, which is God; it follows that God Himself is the cause of every operation as its end. Again it is to be observed that where there are several agents in order, the second always acts in virtue of the first, for the first agent moves the second to act. And thus all agents act in virtue of God Himself; and therefore He is the cause of action in every agent. Thirdly, we must observe that God not only moves things to operate, as it were applying their forms and powers to operation, just as the workman applies the axe to cut, who nevertheless at times does not give the axe its form; but He also gives created agents their forms and preserves them in being. Therefore He is the cause of action not only by giving the form which is the principle of action [...]; but also as preserving the forms and powers of things [...] Since the form of the thing is within the thing, since [form] is of more importance as it is prior and more universal, and since God is properly the cause in all things of universal being, which is the most intimate reality in things, it follows that God operates intimately in all things»⁵¹.

For Aquinas, God is at work in every operation of nature, but the autonomy of nature is not an indication of some reduction in God's power or activity; rather, it is an indication of His goodness. To ascribe to God (as first cause) *all* causal agency «eliminates the order of the universe, which is woven together through the order and connection of causes. For the first cause lends from the eminence of its goodness not only to other things that they are, but also that they are causes»⁵². Nor does Aquinas think that an eternal universe has to mean, as Maimonides, al-Ghazali, and others argued, a necessary universe, a universe which is not the result of the free creative act of God. An eternal, created universe would have no first moment of its existence, but, as Avicenna⁵³ had noted, it still would have a cause of its existence.

⁵¹ *Summa theologiae* I q. 105, a. 5.

⁵² *De veritate* q. 11, a. 1. See also *Summa theologiae* I q. 22, a. 3, and q. 23, a. 8, ad 2. «Creation is not mingled in the works of nature but is presupposed for the operation of nature» (*Summa theologiae* I q. 45, a. 8).

⁵³ Avicenna's understanding of the relationship between God, the absolutely necessary being, and the created order of things which are, in themselves, only possible will contribute to Aquinas' understanding of creation. In his monumental *al-Shifā': al-Ilāhiyyā*, Avicenna writes: «This is what it means that a thing is created, that is, receiving its existence from another [...] As a result everything, in relat-

For Aquinas there are two senses of creation out of nothing, one philosophical, the other theological. The philosophical sense simply means that God, with no material cause, makes all things to exist as entities that are really different from His own being yet completely dependent upon His causality. The theological sense of creation denies nothing of the philosophical sense but merely adds to it the notion that the created universe is temporally finite. Thus, reason alone can arrive at an understanding of the essential features of the doctrine of creation —of everything, that is, but the temporal beginning of the world. Aquinas also thinks that the causality of Aristotle's unmoved mover is able to be understood —or perhaps expanded to include— the causality of creation. Despite the difficulties that the attribution of an understanding of creation to Aristotle raises for Aristotelian scholars, it reveals the extent to which Aquinas finds a complementarity between reason and faith⁵⁴.

ion to the first cause, is created [...] Therefore, every single thing, except the primal One, exists after not having existed with respect to itself» (*al-Shifā'*: *al-Ilāhiyyā*, VIII 3, translated in Georges ANAWATI, *La Métaphysique du Shifā'* [Paris, 1978], vol. II, pp. 83-84: «C'est ce qui veut dire que la chose est créée, i. e., recevant l'existence d'un autre [...] Par conséquent le tout par rapport à la Cause première est créé [...] Donc toute chose, sauf l'Un premier, existe après n'avoir pas existé au égard à elle-même [*bistihqaq nafsihi*.]»).

«When some thing through its own essence is continuously a cause for the existence of some other thing, it is a cause for it continuously as long as its essence continues existing. If it [the cause] exists continuously, then that which is caused exists continuously. Thus, what is like this [cause] is among the highest causes, for it prevents the non-existence of something, and is that which gives perfect existence to something. This is the meaning of that which is called "creation" [*ibda'*] by the philosophers, namely, the bringing into existence of something after absolute non-existence. For it belongs to that which is caused, in itself, that it does not exist [*laysa*], while it belongs to it from its cause that it does exist [*aysa*]. That which belongs to something in itself is prior, according to the mind, in essence, not in time to that which comes from another. Thus, everything which is caused is existing after non-existing by a posteriority in terms of essence [...] If [an effect's] existence comes after absolute non-existence, its emanation from the cause in this way is called *ibda'* ("absolute origination"). This is the most excellent form of the bestowal of existence, for (in this case) non-existence has simply been prevented and existence has been given the sway *ab initio*» (*al-Shifā'*: *al-Ilāhiyyā*, II.266, quoted in Barry KOGAN, *Averroes and the Metaphysics of Causation* [Binghamton, NY: State University of New York Press, 1985], p. 276, n. 58). See also F. RAHMAN, «Ibn Sina's Theory of the God-World Relationship», in *God and Creation*, edited by David Burrell and Bernard McGinn (University of Notre Dame Press, 1990), pp. 38-56.

⁵⁴ For a list of the passages in which Aquinas claims that Aristotle holds that the world is created, see Appendix D in Steven E. BALDNER and William E. CARROLL, *Aquinas on Creation* (Toronto: Pontifical Institute of Mediaeval Studies, 1997). The following is one of these passages: «Hence just as some things are always true and yet have a cause of their truth, so Aristotle thought that some beings are eternal, namely celestial bodies and separated substances, but nevertheless they have a cause of their being [*haberent causam sui esse*]. From this it is clear that, although Aristotle held that the world is eternal, he did not believe that God is the cause only of the motion of the world and not its being [*non tamen credidit quod Deus non sit causa essendi ipsi mundo, sed causa motus eius tantum*], as some have said» (*In VIII Phys.*, lect. 2, n. 996). See William E. CARROLL, «San Tommaso, Aristotele, e la creazione»: *Annales Theologici* VIII (1994) 365-376; and Lawrence DEWAN, «St. Thomas, Aristotle, and Creation»: *Dionysius* XV (1991) 81-90. Dewan has also provided a trenchant analysis of Gilson's discussion of this question in «Thomas Aquinas, Creation, and Two Historians»: *Laval théologique et philosophique* L (1994) 363-387. Robert Sokolowski offers a different view in that he thinks that Aquinas' elaboration of the «metaphysics of *esse* [...] does not focus sufficiently on the contrast between such

Aquinas observes that «the causality of the Creator [...] extends to everything that is in the thing. And, therefore, creation is said to be *out of nothing*, because nothing uncreated pre-exists creation»⁵⁵. The Creator is prior to what is created, but the priority is not *fundamentally* temporal. Creation has its origin in a creator and is wholly dependent upon the Creator for its existence; the dependence is metaphysical not temporal:

«[N]on-being is prior to being in the thing which is said to be created. This is not a priority of time or of duration, such that what did not exist before does exist later, but a priority of nature, so that, if the created thing is left to itself, it would not exist, because it only has its being from the causality of the higher cause [*ex influentia causae superioris*]»⁵⁶.

As we have seen, Thomas Aquinas saw no contradiction in the notion of an eternal created universe⁵⁷. For, even if the universe had no temporal beginning, it still would depend upon God for its very being. The radical dependence on God as cause of being is what creation means. The kind of contingency which creatures *qua* creatures possess extends to necessary beings⁵⁸, that is, those which, although

metaphysics and the pagan philosophy of being». For Sokolowski, the doctrine of creation is at the boundary between reason and faith in that it requires a radical distinction between the Creator and creature, a distinction unknown, indeed unknowable, to pagan thought (cf. *The God of Faith and Reason* [University of Notre Dame Press, 1982], pp. 113 ff.). See also, John F. X. KNASAS, «Aquinas' Ascription of Creation to Aristotle» *Angelicum* LXXIII (1996) 487-506. I am grateful to Steven E. Balúner for his many helpful comments on this topic.

⁵⁵ *In II Sent.*, dist. 1, q. 1, a. 2, resp.

⁵⁶ *Ibid.* See Appendix.

⁵⁷ Aquinas' most sophisticated discussion of this subject is in *De aeternitate mundi*: «Thus it is evident that the statement that something was made by God and nevertheless was never without existence, does not involve any logical contradiction» (n. 306). See also *In VIII Phys.*, lect. 1, n. 970. Aquinas distinguishes between «eternity» predicated of God—which means non-successive, totally actual existence, with no before or after—, and «eternity» as predicted (at least hypothetically) of the universe—which means an unending (and beginningless) duration of time, in which there is succession in terms of before and after.

⁵⁸ Aquinas distinguishes the necessary from the contingent by noting (following Aristotle) that to be necessary means «cannot be otherwise». In fact, Aquinas generally distinguishes between necessary and contingent beings *in the created order*: «Among the parts of the whole universe, the first distinction to be observed is between the contingent and the necessary. For the highest beings are necessary, incorruptible, and immobile» (*Summa contra Gentiles* III c. 94). For Aquinas there are beings which are absolutely necessary because in them there is no potency to non-being. Material beings, on the other hand, possess a potency with respect to other forms and thus «can be other» than they are. Aquinas often observes that «to be simply necessary is not incompatible with the notion of created being». (*Summa contra Gentiles* II c. 30). «Things are said to be necessary and contingent according to a potentiality that is in them, and not according to God's potentiality» (*Summa contra Gentiles* II c. 55). God, as necessary being, is necessary *per se*; created necessary beings have a cause of their being, and hence of the fact that they cannot be otherwise. For a good discussion of contingency and necessity in Aquinas, and how they relate to his notion of creation, see Jan AERTSEN, *Nature and Creature: Thomas Aquinas's Way of Thought* (Leiden, E. J. Brill, 1988), pp. 236-248. Referring to the last passage cited from the *Summa contra Gentiles*, Aertsen observes that for Aquinas: «Necessity and contingency in things are distinguished not with reference to the first cause, God, but in relation to their next causes, the intrinsic principles of form and matter. Both modes of being do find their ultimate origin in God. For He is the universal cause of being, thus also of the differences of being, the contingent and the

created, do not undergo corruption or change⁵⁹. It is easy to confuse different senses of contingency. There have been suggestions recently that, despite the radical altering of the nature of time in Hawking's cosmology, Hawking's view reinforces the idea of the creaturely contingency of the universe. Robert J. Russell, director of the Center for Theology and the Natural Sciences at Berkeley, claims that:

«Because of his [Hawking's] insistence on the distinction between a finite past and a beginning of time, Hawking has, in effect, helped us claim that the universe is indeed a creation of God even if it has no beginning»⁶⁰.

It is the concept of finitude which Russell considers the key to the Christian doctrine of creation *ex nihilo*⁶¹, and which he sees affirmed by Hawking. It may be

necessary. In keeping with the "*lex necessitatis vel contingentiae*" [*In VI Metaph.*, lect. 3, n. 1222] set by Him, the causality of finite things is ordered. The creating cause itself transcends this order» (p. 243).

⁵⁹ Aquinas, following Aristotelian cosmology, thought that the heavenly bodies were necessary beings: they are neither generated nor destroyed, although they are created.

⁶⁰ Robert John RUSSELL, «Finite Creation Without a Beginning», *op. cit.*, p. 325. Russell thinks it is useful to distinguish between two closely related claims: 1) «that the universe, as God's creation, must have a finite past (i.e., that it has not existed forever)»; and 2) «that in order to have a finite past, the universe must have had a beginning». «Hartle/Hawking have shown us that the latter claim is not logically or mathematically necessary to the former claim». Russell claims that truly theologically important claim is #1 and not #2. «Hawking's work has the effect of disabusing us of an unnecessary adumbration to the central implication about the finitude of creation as it devolves out of the doctrine of *creatio ex nihilo*» (p. 325).

⁶¹ Russell thinks that Langdon Gilkey, in *Maker of Heaven and Earth: The Christian Doctrine of Creation in the Light of Modern Knowledge* ([reprint] Lanham: University Press of America, 1985; [originally published] Garden City, Doubleday, 1959), is the source of sustained reflection by contemporary Protestant theologians on the relation between science and the Christian doctrine of creation. Gilkey distinguishes between two different senses of origination: «ontological origination» and «historical/empirical origination». The former is the claim that God creates *ex nihilo* whatever is, as it exists; whereas the latter is the claim that there was a first event, a beginning of the universe, and hence a beginning of time. Gilkey thinks that modern science challenges creation in the historical sense since such a view of creation presupposes a static cosmology. Furthermore, Gilkey argues that knowledge about a first moment of time cannot be a legitimate part of theology since theology does not contain any «facts» about the natural order: revelation does not «inform us of its [the natural order's] character or constitution». (pp. 312-314). Gilkey concludes: «[t]he idea of a beginning to time has a great theological and cultural value; but [...] we have been forced to deny that there can be for theology any factual content to this idea» (p. 315). Arthur Peacocke (*Creation and the World of Science: The Bampton Lectures, 1978* [Oxford: Clarendon Press, 1979]); and «Theology and Science Today», in *Cosmos as Creation: Theology and Science in Consonance*, ed. Ted Peters (Nashville: Abingdon Press, 1989), pp. 28-43) follows Gilkey's lead and argues that the question of the absolute beginning of time is theologically unimportant. Ian Barbour (*Issues in Science and Religion* [New York: Harper and Row, 1966]); and *Religion in an Age of Science, The Gifford Lectures 1989-1991*, vol. 1 (San Francisco: Harper and Row, 1990)) agrees that $t=0$ is irrelevant to the notion of creation.

Russell agrees with Gilkey, Peacocke, and Barbour that the crucial sense of creation *ex nihilo* involves «ontological origination», but he does not think that ontological origination should be seen as devoid of historical/empirical meaning. Russell correctly observes that Gilkey's dichotomy is not consistent with the views of Aquinas to whom Gilkey appeals. Russell is right. Aquinas distinguishes between a philosophical sense of creation and a theological sense. Gilkey reduces the theological to the philosophical. Aquinas, of course, thinks that the full sense of creation includes the notion of the

that Russell grants too much to Hawking's view of finitude, since for Hawking finitude remains a physical not a metaphysical concept.

Aquinas, of course, would note that to argue that the universe has no beginning (either because it is eternal as the ancients thought, or because the very notion of temporality is a subsidiary concept as Hawking thinks) does not challenge the fundamental metaphysical truth that the universe has an origin, i.e., that the universe is created.

There is no necessary conflict between the doctrine of creation and any physical theory. Theories in the natural sciences account for change. Whether the changes described are biological or cosmological, unending or temporally finite, they remain processes. Creation accounts for the existence of things, not for changes in things.

There were some thinkers in the Middle Ages, in each of the three great religious traditions, who thought that science could demonstrate that the universe had a temporal beginning⁶². Such confidence in our ability to know that the universe is

temporal beginning of the universe. Russell, here following Aquinas, writes that «[o]ntological dependence is thus the *crucial*, but not the *exhaustive* meaning of creation» (RUSSELL, p. 308).

Russell's approach to the question of the relationship between creation and science involves the adopting of what he calls a «Lakatosian Theological Research Program», that is a method of analysis using the methodology suggested by Imre Lakatos («Falsification and the Methodology of Scientific Research Programmes», in *The Methodology of Scientific Research Programmes: Philosophical Papers*, vol 1, ed. John Worrall and Gregory Currie [Cambridge: Cambridge University Press, 1978], pp. 8-101). Such a program involves the establishment of a «core hypothesis surrounded by a protective belt of auxiliary hypotheses which can be tested against relevant data [...] In this way evidence for empirical origination from contemporary science, such as the Big Bang offers in terms of $t=0$, could be related to a core theological hypothesis in such a way as to allow it to confirm ontological origination without the evidence being somehow directly identified with [the] core hypothesis» (RUSSELL, p. 308). But we must remember that «ontological origination» is first of all a metaphysical claim. Indeed, Aquinas thinks that reason alone can demonstrate such a conclusion. The theological doctrine of creation, for Aquinas, includes the metaphysical claim and adds that the universe is temporally finite.

Russell's fascination with the implications of Hawking's cosmology finds its roots in two claims Russell makes. First, his core Lakatosian hypothesis: «*creatio ex nihilo* means ontological origination». An «auxiliary hypothesis» which «surrounds the core» is: «ontological origination entails finitude». By «finitude» Russell means «something with determinate status, measure or boundary, as opposed to the *apeiron*, that which is unbounded, unlimited, endless extensible». A further auxiliary hypothesis is: «finitude includes temporal finitude». And yet another, «temporal finitude includes past temporal finitude». Finitude, Russell thinks, can serve «as a bridge between the core theory, ontological origination, and the data for theology, here seen in terms of the origin of the universe at $t=0$ [...]». Thus, Russell concludes that «the empirical origination described by $t=0$ in Big Bang cosmology tends to confirm what is entailed by theological core theory, «*creatio ex nihilo* means ontological origination»» (RUSSELL, p. 309).

Although temporal finitude is a kind of finitude, it does not follow that something which is finite must somehow be temporally finite. The finitude/contingency of creatures does not exclude the possibility of necessarily existing or eternal creatures, as Aquinas argued. Obviously, if one starts with the view that the universe is in fact temporally finite one can find scientific confirmation of creation *ex nihilo*. I am not persuaded, however, that contemporary science offers the kind of evidence which can lead one to conclude that the universe is temporally finite in the sense necessary to require that it be created *ex nihilo*. Accordingly, I do not really see the bridge to which Russell points.

⁶² Some were attracted to the argument of John Philoponus who, as early as the sixth century, claimed that the impossibility of an actual infinity of past days necessarily required that the universe

temporally finite can be seen as well in the arguments of many Big Bang cosmologists. Aquinas, however, following the lead of Maimonides⁶³ argued that, in principle, science cannot conclude that the universe has a temporal beginning. Although, as we have seen, Aquinas did think that reason can demonstrate that the universe has an origin, that is, that it is radically dependent upon a cause for its existence, he thought that it was an error to think that, on the basis of how we understand the universe in its current state, we can extrapolate or reason to an initial state or temporal beginning of the universe⁶⁴. Thus, contrary to Hawking's observation quoted earlier in this essay, there are different senses of beginning: an absolute temporal beginning of the universe is quite unlike any beginning which occurs in the universe.

Aquinas did *believe* that the universe is not eternal; Aristotle, he thought, was wrong to think that it was. But Aquinas argued that, on the basis of reason alone, one could not know whether the universe is eternal. To affirm, on the basis of faith, that the universe has a temporal beginning⁶⁵ involves no contradiction with what the natural sciences can legitimately proclaim. Since the natural sciences cannot know whether the universe has a temporal beginning, a revelation in faith on this subject completes and perfects what reason knows⁶⁶.

have an absolute temporal beginning. R. SORABJI (ed.), *Philoponus and the Rejection of Aristotelian Science* (Cornell University Press, 1987), and *Philoponus: Against Aristotle on the Eternity of the World*, translated by Christian Wildberg (Cornell University Press, 1987). See also, DAVIDSON, *op. cit.*

⁶³ Moses MAIMONIDES, *The Guide of the Perplexed*, translated by S. Pines (The University of Chicago Press, 1963) I 71, p. 180.

⁶⁴ Aquinas remarks: «[...] those err who, on the basis of the manner of things' coming-to-be in a world already [in a state of] complete [being], want to show the necessity or the impossibility of a beginning of the world. This is because what now begins to be, begins through a motion. Hence a mover must precede it in duration. Also, a nature must precede it; and these must be contraries. But none of these things is necessary for the coming forth of the universe by God's agency» (*In II Sent.*, dist. 1, q. 1, a. 5).

⁶⁵ Aquinas believed that the opening of Genesis revealed that the universe had a temporal beginning. He also knew that the Fourth Lateran Council (1215) proclaimed as much: «We firmly believe and simply confess that there is only one true God [...], one origin [*principium*] of all things: Creator of all things, visible and invisible, spiritual and corporeal; who by His own omnipotent power from the beginning of time [*ab initio temporis*] all at once made out of nothing [*de nihilo condidit*] both orders of creation, spiritual and corporeal, that is, the angelic and the earthly». For a discussion of Aquinas' knowledge of this doctrine, see WILLIAM A. WALLACE, «Aquinas on Creation: Science, Theology, and Matters of Fact»: *The Thomist* XXXVIII (1974) 485-523.

⁶⁶ Aquinas did not think that the opening of Genesis presented any difficulties for the natural sciences. The Bible is not a textbook in the sciences. What is essential to Christian faith, according to Aquinas, is the fact of creation, not its manner or mode. In commenting on different views concerning whether all things were created simultaneously and as distinct species, Aquinas remarks: «There are some things that are by their very nature the substance of the faith, as to say of God that He is three and one [...] about which it is forbidden for anyone to think otherwise [...] There are other things that relate to the faith only incidentally [...] and, with respect to these, Christian authors have different opinions, interpreting the Sacred Scripture in various ways. Thus with respect to the origin of the world, there is one point that is of the substance of faith, *viz.*, to know that it began by creation [...] But the manner and the order according to which creation took place concerns the faith only incidentally [...]» (*In II Sent.*, dist. 12, q. 3, a. 1). See also *De potentia Dei*, q. 4, a. 2. Aquinas' firm adherence

The Big Bang described by modern cosmologists is a change; it is not creation. The natural sciences cannot themselves provide an ultimate account for the existence of all things. It does not follow, however, that reason remains silent about the origin of the universe. Reason embraces more than the categories of the natural sciences. As we have seen, although Aquinas does not think that reason alone can conclude that the universe has a temporal beginning, he does think that reason alone can demonstrate that the universe is created.

A universe which is the result of the fluctuation of a primal vacuum is not a self-creating universe. Nor is this primal vacuum the nothingness affirmed in creation out of nothing. Contrary to Carl Sagan's claim that the universe described by contemporary cosmology leaves nothing for a Creator to do, were a Creator not causing all that is there would be nothing done! Hawking is wrong to conclude that there are implications for God as creator "if the universe is completely self-contained, with no singularities or boundaries, and completely described by a unified theory"⁶⁷. One mistake which Hawking and Sagan make in their denial of creation is the old error—which Aquinas pointed out—of thinking that *ex nihilo* necessarily means *post nihilum*. Thus, by denying the latter, they think that they also deny the former. Another mistake they make is to think that to create means to be an agent cause of change. Hawking denies that there is an initial change—his universe has no initial boundary, no beginning—thus, he thinks there is no active role for God to play. But since creation is not a change, Hawking's speculations do not really deny God's creative agency.

The need to explain the existence of things does not disappear as a result of new explanations which propose to account for various changes (or even to deny them), regardless of how ancient or primordial these changes are. Thomas Aquinas would have no difficulty accepting Big Bang cosmology, even with its recent variations, while also affirming the doctrine of creation from nothing. He would, of course, distinguish between advances in cosmology and the philosophical and theological reflections on these advances.

The variations in Big Bang cosmology which I have described are only theoretical speculations, and they are likely to change. To speculate, however, does not justify failures to make distinctions among the domains of the natural sciences, metaphysics, and theology. Nor does it justify fanciful philosophical and theological conclusions about a universe without cause. Thomas Aquinas did not have the advantage of the Hubble Space Telescope, but in many ways he is able to see farther and more clearly than those who do.

to the truth of Scripture without falling into the trap of what we might call literalistic readings of the text would offer valuable correction for some contemporary exegesis of the Bible which concludes that one must choose between the literal interpretation of the Bible and modern science.

⁶⁷ *A Brief History of Time, op. cit.*, p. 174.

APPENDIX

THOMAS AQUINAS, *WRITINGS ON THE SENTENCES OF PETER LOMBARD*,
BOOK II, DISTINCTION 1, QUESTION 1, ARTICLE 2, RESPONSE⁶⁸

«I answer that not only does faith hold that there is creation but reason also demonstrates it. It is clear, for instance, that whatever is imperfect in some category arises out of that in which the nature of the category⁶⁹ is found primarily and perfectly. In [the category of] hot things, for example, [the degrees of] heat arise from fire⁷⁰. Since every thing and whatever is in the thing shares in *being* in some way, and since every thing has imperfection mixed in, every thing must, in its entirety, arise from the first and perfect being. This, however, we call to create: to produce a thing into being according to its entire substance».

«It ought to be known, moreover, that the meaning of creation includes two things. The first is that it presupposes nothing in the thing which is said to be created. In this way it differs from other changes, because a generation presupposes matter, which is not generated, but rather which is transformed and brought to completion through generation. In other changes a subject which is a complete being is presupposed. Hence, the causality of the generator or of the alterer does not extend to everything which is found in the thing, but only to the form, which is brought from potency into actuality. The causality of the Creator, however, extends to everything that is in the thing. And, therefore, creation is said to be out of *nothing*, because nothing uncreated pre-exists creation».

«The second thing is that non-being is prior to being in the thing which is said to be created. This is not a priority of time or of duration, such that what did not exist before does exist later, but a priority of nature, so that, if the created thing is left to itself, it would not exist, because it only has its being from the causality of the higher cause. What a thing has in itself and not from something else is naturally prior in it to that which it has from something else. (In this way creation differs from eternal generation⁷¹, for it cannot be said that the Son of God, if left to Himself, would not have being, since He receives from the Father that very same being which the Father has, which is absolute being, not dependent upon anything)».

⁶⁸ This translation is from Steven E. BALDNER and William E. CARROLL, *Aquinas on Creation* (Toronto: Pontifical Institute of Mediaeval Studies, 1997).

⁶⁹ Any category or genus of beings is a category because all of the members of it share the same nature. If the members of the category share the same nature but do so to different degrees, then the fact that there are less perfect members indicate that there is a most perfect member. The nature that is shared by all the members of the category—the «nature of the category»— is found in its most perfect instance in one member.

⁷⁰ Aquinas regarded fire in its elemental, pure form to be the hottest of things. The fire of a burning match or of a camp fire would be a derivative fire and would be less hot than pure fire.

⁷¹ «Eternal generation» describes the relation between the Son and the Father in the Trinity: the Son is «eternally begotten» of the Father, not created by the Father. Since the Son is not a creature, it is not true to say that non-being is prior to being in the Son, since the being of the Son and the Father is just the same. The Son is «one in being with the Father» and «not made».

«Because of these two points, creation is said to be “out of nothing” [*ex nihilo*] in two ways. On the one hand, the negation [in the word “nothing”] denies the relation implied by the preposition “out of” [*ex*] to anything pre-existing. Thus, the creature is said to be “out of nothing” because it is “not from something pre-existing”. And this is the first point. On the other hand, the order of creation to a pre-existent nothing remains affirmed by nature, such that creation is said to be “out of nothing” because the created thing naturally has non-being prior to being. If these two points are sufficient for the meaning of creation, creation is able to be demonstrated and in this way philosophers have held [the doctrine of] creation».

«If, however, we should add a third point to the meaning of creation, that the creature should have non-being prior to being [even] *in duration*, so that it is said to be “out of nothing” because it is temporally after nothing, in this way creation cannot be demonstrated and it is not granted by philosophers, but is taken on faith».

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