God and Physics: From Hawking to Avicenna

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Main Text

The first religious obligation of every intelligent boy who comes of age, as marked by years or by the dreams of puberty, is to form the intention of reasoning as soundly as he can to an awareness that the world is originated.

Abū 'l-Ma'āli al-Juwaynī (1028-1085)[1]

Al-Juwaynī thought that an awareness of the originatedness [*hud_th*] of the world necessarily meant a rejection of any claim to its being eternal and led, consequently, to the affirmation that it was created by God. He argues that it is reasonable to hold that the world is temporally finite -- this is what it means to be originated -- and that, on the basis of such an observation, one can come to know that there is a Creator. Furthermore, knowledge of creation is knowledge of divine sovereignty, which leads one to submit religiously to God's plan.

Discussions about the relationship between physics and theology — between our knowledge of the world of nature and our knowledge of God — are one of the enduring features of Western culture. Although my remarks will have as their focus developments in the Christian Latin West, we need to remember that in the natural sciences and in philosophy the Latin West was heavily influenced by the work of Muslim and Jewish thinkers. In some of my comments today and in my next lecture I hope to show the nature and extent of that influence.

The twin pillars of every civilization are religion and science. Contemporary cosmological theories, especially discourse about the origins of the universe, reveal the continuing encounter between physics and theology. It is a discourse which interests thinkers of our own age as much as it did those in the Middle Ages. I should like to sketch some of the current discussion in order to suggest how the contemporary world can learn a great deal from mediaeval analyses of the relationship among physics, metaphysics, and theology. In fact, to go from Stephen Hawking to Avicenna is, in an important sense, to go from confusion to clarity.

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 billion.

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."[2] 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."[3] More recently he has argued that we can

have no scientific theory of nature unless the theory accounts for the beginning of the universe.

> 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.[4]

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 creation.[5]

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 cosmologists.[6] 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 laboratories, so the whole universe may be the result of a similar process.[7] 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."[8]

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.

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."[9]

Paul Davies, 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 it.[10]

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 subnuclear 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. . .?[11]

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."[12] 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."[13] 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*."[14]

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."[15] 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.[16]

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?"[17] 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.

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 choose 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?[18]

Carl Sagan, in his introduction to *A Brief History of Time*, argues that Hawking's cosmology shows us "a universe with no edge in space, no beginning or end in time, and nothing for a Creator to do."[19]

One of the more prolific writers on current cosmology is John Barrow, professor of astronomy at the University of Sussex. 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 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."[20]

It is interesting that some Christians rushed to embrace Big Bang cosmology because they saw it as scientific confirmation of the Genesis story of creation.[21] 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 superfluous.[22] I think that an examination of the discussion of physics and theology in the Middle Ages, especially the development by Thomas Aquinas of the doctrine of creation out of nothing, will enable us to see that 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 represents 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 sciences.[23] There is no better way, I think, to begin to understand this discussion than to focus on the development of the doctrine of creation. This will serve as the unifying theme of my reflections in several of my lectures. In fact, I will claim that 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.

The story of the reception of Greek science, and in particular of the texts of Aristotle, in the Latin West is readily available and I do not want to retell it here. The footnotes to this lecture provide references to these texts. I do wish, however, to make a few brief comments on the reception of Greek learning.

The development of cathedral schools in the eleventh and twelfth centuries, a part of the reform program championed by the papacy, brought renewed interest in the heritage of classical antiquity.[24] At Chartres, for example, there was extensive study of Plato's cosmological work, the *Timaeus*, along with Chalcidius' commentary, as well as of Martianus Capella's *Marriage of Philology and Mercury*, Macrobius' *Dream of Scipio*, Seneca's *Natural Questions*, Cicero's *On the Nature of the Gods*, along with works by Augustine, Boethius, and John Scotus Eriugena. The *Timaeus* was particularly important in that it contained the most systematic discussion of questions in cosmology and physics. Thierry of Chartres (d. after 1156) was especially influential in his attempt to use Platonic cosmology in his reading of the creation account in Genesis.[25]

"The revival of learning began as an attempt to master and exploit traditional Latin sources. However, before the end of the twelfth century it was transformed by the infusion of new books, containing new ideas, freshly translated from Greek and Arabic originals. This new material, first a trickle and eventually a flood, radically altered the intellectual life of the West."[26]

The Christian reconquest of Toledo in Spain in 1085 and the Norman conquest of southern Italy and Sicily in the late eleventh century provided the opportunity for the translation of a significant number of texts from Arabic and Greek into Latin. In the twelfth century, under the sponsorship of the Archbishop of Toledo, a team of scholars led by Dominic Gundissalinus translated works by Avicenna, al-Farabi, and al-Kindi. Gerard of Cremona (ca. 1114-87) learned Arabic and translated most of the Aristotelian works in the natural sciences. Gerard translated seventy-one works from the Arabic. As James Weisheipl has observed, Gerard deserves recognition as the "midwife of Western science."[27] In the thirteenth century Robert Grosseteste[28] and William of Moerbeke[29] labored tirelessly to produce even better translations of Greek texts. Between 1200 and 1209, Grosseteste, the renowned Oxford master, produced the first full exposition of the *Posterior Analytics*, a text which John of Salisbury in the previous century described as having as many barriers to understanding as there were chapters. By 1220 Averroes' commentary on this text appeared in Latin. It is difficult to underestimate the importance of the *Posterior Analytics* in Western intellectual history since it represents Aristotle's systematic exposition of his understanding of the nature of science and the role of demonstration in acquiring knowledge of nature. By late 1260s both Albert the Great and Thomas Aquinas had completed extensive commentaries on this work.

The curriculum of the newly established universities, especially at Oxford and Paris, would eventually be revolutionized by the influx of the new learning. Although there is some evidence that there were lectures on Aristotle's "logica nova" in the first decade of the thirteenth century at both universities, there is little evidence of significant influence until the 1240s and 1250s. In 1210, in 1215, and again in 1231 Aristotle's works "concerning natural philosophy" were formally banned from the curriculum at Paris, but this early hostile reaction eventually dissipated so that by the middle of the century Aristotelian texts were taught openly. The reaction to a radical form of Aristotelianism which resulted in formal condemnations by the Bishop of Paris in 1270 and 1277 will be the subject of a future lecture, so I will set aside for now any detailed account of the reception of Aristotle in the thirteenth century.

The controversies in the Latin West were in important ways anticipated in the Islamic world, and I want to devote the remainder of my remarks to mediaeval Islamic culture since Aquinas' development of his understanding of creation depends heavily upon the work of medieval Muslim thinkers. Furthermore, as I have already indicated, there is no more important area of encounter among the natural sciences, theology, and metaphysics than the topic of creation.

The reception of Greek philosophy in the Islamic world is a complex story.[30] Well before the rise of Islam, Nestorian Christians in Syria and Persia established centers of learning producing translations of Greek texts into different Near Eastern languages (especially Syriac and later Arabic). By the middle of the eighth century the 'Abassid caliphs had built the new capital city of Baghdad[31] and under their influence the Hellenization of the Islamic world accelerated. The caliph al-Ma'm_n (813-833) founded a research institute, the House of Wisdom, in Baghdad, which served as the center for translations.[32] The primary interest was in medical texts, but a few Platonic dialogues, including the *Timaeus*, Euclid's *Elements*, and Ptolemy's *Almagest* were translated. By the year 1000 A.D. "almost the entire corpus of Greek medicine, natural philosophy, and mathematical science had been rendered into usable Arabic versions."[33]

The role of Greek science in Islamic culture continues to be the subject of scholarly controversy: that is, whether it existed only on the margins of Islamic culture or whether it was appropriated into that culture and served an important role in the development of law and theology. It does seem clear, however, that the claim that science in Islam remained simply a matter of being faithful to Greek thinking and, hence, "was destitute of all originality," is false.[34] Whatever their role of disciples might involve, Muslim scientists made important contributions to medicine, astronomy, optics, and mathematics.[35]

As we remember that the focus of my comments concerns, if not "the dreams of puberty," at least that "religious obligation . . . to form the intention of reasoning as soundly as . . . [we] can to an awareness that the world is originated," let us turn our attention to theology and the natural sciences in the Islamic setting. As early as 932 there was a famous public debate in Baghdad over the merits of the "new learning."[36] Greek

philosophy seemed particularly challenging to many Muslim theologians (*mutakallimun*) who came to view it with suspicion as an alien way of thinking. Divine sovereignty and the radical contingency of the created order must be protected from the encroachments of Greek logic and an Aristotelian science which sought to discover the necessary nexus between cause and effect. Any necessity posited in the created order seemed to threaten divine omnipotence and, accordingly, many theologians embraced a radical occasionalism which saw events in the world as only the occasions for divine action. God alone is the true cause of all that happens. The position which these Muslim theologians feared can be found in the work of al-Farabi (870-950), who established in Cairo a curriculum for the study of Plato and Aristotle, and of Avicenna (980-1037), whose writings in medicine, natural philosophy, and metaphysics proved to be extraordinarily influential. Their work offers an excellent example of the way in which Greek thought could be appropriated in the Islamic world.[37] Also, Avicenna, translated into Latin, will prove to be especially important for Thomas Aquinas, as we shall see. 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-Shifa': al-Ilahiyyat*, Avicenna writes: "This is what it means that a thing is created, that is, receiving its existence from another . . . . As a result everything, in relation to the first cause, is created. . . . Therefore, every single thing, except the primal One, exists after not having existed with respect to itself."[38]

In explaining the kind of agent (or efficient) causality which creation involves, Avicenna notes that there is an important difference between the ways in which metaphysicians and natural philosophers discuss agent cause:

> . . . the metaphysicians do not intend by the agent the principle of movement only, as do the natural philosophers, but also the principle of existence and that which bestows existence, such as the creator of the world.[39]

The recognition that creation is properly a subject of metaphysics and not of physics (i.e., of natural philosophy) will be particularly important for Aquinas, as will Avicenna's insistence on the distinction between essence and existence. With respect to the latter topic, Avicenna observes that a reflection on what it means for something to be reveals that what something is -- i.e., its essence -- is different from whether a thing exists. On the basis of the ontological distinction between essence and existence, Avicenna argues that all beings other than God (in whom this distinction disappears) require a cause in order to exist.[40]

Avicenna's distinction between existence and essence is part of his contribution to a long standing intellectual project which sought to understand the relationship between existing individuals and their "intelligible natures." Those schooled in the Neoplatonic tradition gave ontological priority to the intelligible nature; hence, the attraction of an emanationist scheme according to which all existing things flow from a primal source of being and intelligibility. The immediate context of Avicenna's distinction between existence and essence is his discussion of necessary and possible being. Aquinas follows Avicenna's lead but comes to recognize a rather different sort of creaturely contingence from that of

Avicenna. For Avicenna, essence is something prior and to which existence "happens" or comes as an accident.[41] According to Avicenna, "real existence" emerges as a new attribute for the contingent being of the created world (which was originally present as an essence or "possibility" in the divine mind); it is "a kind of added benefit bestowed by God upon possible being in the act of creation."[42] As David Burrell observes, Aquinas will use Avicenna's distinction between essence and existence but develop the notion of radical dependency in such a way that creaturely existence is understood not as something which happens to essence but as a fundamental *relation* to the Creator as origin.[43] But I will examine the distinctive contribution of Aquinas on this topic in the next two lectures.

An eternal world was often viewed as a necessary world, a world which, accordingly, was not the result of the free creative act of God. Avicenna sought to be faithful to Greek metaphysics (especially in the Neoplatonic tradition) and also to affirm the contingency of the created order.[44] Although the world proceeds from God by necessity and is eternal, it differs fundamentally from God in that *in itself* it is only possible and requires a cause in order to exist. God, on the other hand, is necessary in Himself and, thus, requires no cause. A key to science, in the sense set forth by Aristotle in his *Posterior Analytics*, is the knowledge of a necessary nexus between cause and effect; only such necessary knowledge truly deserves the name science (*episteme*). Contingent existence, although not necessary in itself (*per se*), is necessary through/by another.[45] Avicenna thought that the contingency of the world he described did not deny natural necessity.[46] Finite creatures are contingent in themselves but necessary with reference to their causes, and ultimately with reference to God. A world without necessary relationships is an unintelligible world. Yet, at the same time, the fear was that a necessary world is a self-sufficient world, a world which cannot not be: the opposite, so it seemed of a world created by God. At best a necessary world would only be a world which *must* surge forth from a primal source of being. The explanation of the absolute origin of the world in terms of a necessary emanationist schema was attractive since it seems to do justice to both necessity and dependence. *Necessity* is demanded by Greek science in order to protect the intelligibility of the world; *dependence* is demanded by theology to protect the 'originatedness' of the world. Creation for Avicenna is an ontological relationship -- a relationship in the order of being -- with no reference to temporality. In fact, Avicenna accepted the established Greek view that the universe is eternal. Obviously, his view of the emanation of existing things from a primal source -- a view which excluded the free act of God -- only made sense in an eternal universe. But, does an emanationist metaphysics do justice to creation? Is it consistent with the God revealed in the Koran or the Bible?

It was precisely such questions which led al-Ghazali (1058-1111), a jurist, theologian, and mystic, to argue against what he considered to be threats to Islam in the thought of philosophers such as Avicenna. In *The Incoherence of the Philosophers* [*Tahafut al-Falasifah*] al-Ghazali sets forth a wide-ranging critique of Greek thought:

> In the three questions. . . they [the philosophers] were opposed to [the belief] of all Muslims, viz. in their affirming (1) that men's bodies will not be assembled on the Last

Day, but only disembodied spirits will be rewarded and punished, and the rewards and punishments will be spiritual, not corporeal . . . they falsely denied the corporeal rewards and punishments and blasphemed the revealed Law in their stated views. (2) The second question is their declaration: 'God Most High knows universals, but not particulars.' This also is out-and-out unbelief. . . (3) The third question is their maintaining the eternity of the world, past and future. No Muslim has ever professed any of their views on these questions.[47]

He defends what he considers to be the orthodox Islamic doctrine of creation versus Avicenna's embrace of an eternal world. Such a world, al-Ghazali thought, was the very antithesis of a created one. An eternal world cannot be dependent upon an act of God, since an eternal world would be a completely self-sufficient world.[48] In fact, al-Ghazali claims that, even on philosophical grounds, all the arguments advanced for an eternal world fail. It is perhaps ironic that Stephen Hawking and Carl Sagan would agree with al-Ghazali in claiming that a universe that has an absolute temporal beginning is what is necessarily meant by a created universe. They, of course, think that by denying such a singularity they have left nothing for a creator to do. Avicenna, as we have seen, argued that creation is a metaphysical dependence — an explanation of the cause of existence of things — and as such creation is not a subject of reflection in the natural sciences. I will pursue this theme in my next lecture, showing that Thomas Aquinas offers an excellent antidote to confusing discussions in our own age about God, physics, and the origin of the world.

The incoherence which al-Ghazali found in Avicenna's position was the affirmation of a world which is simultaneously eternal and created. It would seem to many Muslim theologians that one had to choose between Athens and Mecca, between Greek science and the revelation of the Koran. To seek to embrace both is, so they thought, to be incoherent. In the next lecture we will examine this claim of incoherence as it is rejected by Averroes, Maimonides, and Aquinas. Aquinas will defend the possibility of an eternal world created *ex nihilo* by God. Aquinas' understanding of creation, forged in the midst of the mediaeval controversy about the relationship between Greek science and divine revelation, remains one of the towering achievements of human history. I leave you with a sentence from the young Aquinas, written in the 1250s at the University of Paris: "Not only does faith hold that there is creation but reason also demonstrates it." It is a claim which we shall explore at our next session.

Endnotes

1 From his *Kitab al-Irshad* (*Book of Right Guidance*); quoted in L. E. Goodman, *Avicenna* (London: Routledge, 1992), p. 49. An Ash'arite theologian, he taught al-Ghazali at Nishapur.

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

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

4 Stephen Hawking and Roger Penrose, *The Nature of Space and Time* (Princeton: Princeton University Press, 1996), p. 71.

5 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*, 44, no.1 (février 1988), pp. 59-75; Mariano Artigas, " Física y creación: el origen del universo," *Scripta Theologica*, 29, nos. 1 and 2 (1987), pp. 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.J., and George V. Coyne, S.J. (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*, 24, no. 3 (1993), pp. 359-389; Juan José Sanguineti, *El Origen del Universo: La cosmología en busca de la filosofía* (Buenos Aires: Editorial de la Universidad Catolica Argentina, 1994) and "La creazione nella cosmologia contemporanea," *Acta Philosophica* 4, no. 2 (1995), pp. 285-313; Joseph Zycinski, "Metaphysics and Epistemology in Stephen Hawking's Theory of the Creation of the Universe," *Zygon*, vol. 31, no. 2 (June 1996), pp. 269-284.

6 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.

7 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.

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

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

10 *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.

11 *ibid.*, p. viii.

12 William Lane Craig and Quentin Smith, *op. cit.*, p. 109.

13 *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* 15 (Oxford, 1996), pp. 19-22.

14 *ibid.*, p. 217. Italics are in the original.

15 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," in *Physical Review* D, 28 (1983), pp. 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," in *Nuclear Physics* B 239 (1984), pp. 257-276. See also, Keith Ward's discussion, "Creation and Modern Cosmology," in *Religion and Creation* (Oxford University Press, 1996), pp. 287-315.

16 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.

17 *ibid.*, p. 76.

18 *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 orgination, the Hartle/Hawking model is more compatible with the Christian doctrine of creation *ex nihilo. Beyond the Big Bang: Quantum Cosmologies and God* (LaSalle, IL: Open Court: 1990), especially pp. 70-71.

19 *ibid.*, p. x.

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

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

22 For a discussion of these reactions, see Carroll, "Big Bang Cosmology, Quantum Tunneling from Nothing, and Creation," *op. cit.*, pp. 64-67.

23 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).

24 In the Latin Middle Ages almost all of the works of Aristotle were translated into Latin, either from the Arabic or the Greek, and eventually were the subject of study. The exceptions were the *Eudemian Ethics*, which was never translated, and the *Poetics*, which although translated by William of Moerbeke, remained virtually unknown. Most of the works of Aristotle were translated from the Greek; our knowledge of them comes from a corpus of 2000 manuscripts (dating from the ninth to the sixteenth centuries) in various European libraries. Some of the works were mistakenly attributed to Aristotle. Our knowledge of these translations owes its origin to the initial work of Amable Jourdain who in 1819 published *Recherches critiques sur l'âge et l'origine des traductions latines d'Aristote.* By the middle of the present century the catalogue of these manuscripts appeared and now there is an extensive collection, in the series *Aristoteles latinus*, of critical editions of these translations. See Charles H. Lohr, "Aristotele latinus," in *The Cambridge History of Later Medieval Philosophy*, edited by Norman Kretzmann, Anthony Kenny, and Jan Pinborg (Cambridge University Press, 1982), pp. 45-46. Lohr provides a useful table of all the translations, pp. 74-79. Many of these works were translated more than once. Already in the sixth century Boethius had begun his project of translating all of Plato and Aristotle into Latin, but the only works of Aristotle which we have evidence that he translated are the *Categories*, *De interpretatione*, *Prior Analytics*, *Topics*, and *Sophistici elenchi*: that is, all of what has been called Aristotle's "Organon" with the exception of the *Posterior Analytics.* Lohr, *op. cit.*, p. 53.

For more than five hundred years the knowledge of Greek science in the Latin West depended upon Boethius' translations of Aristotle's logical treatises, his summary of Euclid's Elements, his own treatises on arithmetic and music, as well as a partial translation of Plato's Timaeus and commentaries by Chalcidius and Cicero. Schools established at cathedrals and monasteries, as well as at secular courts, were more concerned with studying grammar, logic, and theology. especially biblical exegesis, than with scientific questions. James A. Weisheipl, OP, The Development of Physical Theory in the Middle Ages (Ann Arbor, MI: Ann Arbor Paperbacks, 1971), pp. 18-19.

25 David Lindberg, The Beginnings of Western Science: The European Scientific Tradition in Philosophical, Religious, and Institutional Context, 600 B.C. to A.D. 1450 (University of Chicago Press, 1992), pp. 190-197. William of Conches (d. after 1154) is a good example of the increasing tendency to affirm the importance of the study of nature. In his Philosophy of the World, William attacks those who too readily appeal to direct divine intervention in the world: "Because they are themselves ignorant of nature's forces and wish to have all men as companions in their ignorance, they are unwilling to investigate them, but prefer that we believe like peasants and not inquire into the [natural] causes [of things]. However, we say that the cause of everything is to be sought. . . . But these people. . . if they know of anybody so investigating, proclaim him a heretic." Andrew of St. Victor, discussing the interpretation of biblical events, cautioned that "in expounding Scripture, when the event described admits of no natural explanation, then and then only should we have recourse to miracles." Quoted in Lindberg, p. 200.

26 Lindberg, *op. cit.*, p. 203

27 Gerard translated Avicenna's *Canons of Medicine* and many works by Galen and Hippocrates. He translated Ptolemy's *Almagest* with Arabic commentaries. He translated Euclid's *Elements* from the Arabic as well as Aristotle's *Physics*, *On the Heavens*, *On Generation and Corruption*, and the *Posterior Analytics.* Weisheipl, *op. cit.*, p. 21. Gerard had come from northern Italy to Spain in the late 1130s or early 1140s in search of a copy of Ptolemy's *Almagest*. He found a copy in Toledo and remained there

where he learned Arabic, and found a treasure trove of other texts to translate. Lindberg, *op. cit.*, pp. 204-5.

28 Grosseteste was first chancellor of Oxford University and bishop of Lincoln from 1235 until his death in 1253. In addition to his role as translator of Aristotle, he was a major political, ecclesiastical, scientific, and philosophical figure in his own right. Charles H. Lohr, "Aristotele latinus," in *The Cambridge History of Later Medieval Philosophy*, edited by Norman Kretzmann, Anthony Kenny, and Jan Pinborg (Cambridge University Press, 1982), p. 61. Lohr provides a useful table of all the translations, pp. 74-79.

29 Moerbeke, a Dominican and friend of Thomas Aquinas, was born in Belgium around 1215. He traveled extensively in Greece and "was presumably a member of the Dominican convent established at Thebes at least since 1253.." He served in the papal court at Viterbo, and in 1278 he was named Archbishop of Corinth in Greece, where he died in 1286. See Lohr, *op. cit.*, pp. 62-3.

30 Oliver Leaman, An Introduction to Medieval Islamic Philosophy (Cambridge University Press, 1985); Herbert A. Davidson, Proofs for Eternity, Creation and the Existence of God in Medieval Islamic and Jewish Philosophy (New York: Oxford University Press, 1987); Fadlou Shehadi, Metaphysics in Islamic Philosophy (Delmar, N.Y.: Caravan Books, 1982); F.E. Peters, Aristotle and the Arabs: The Aristotelian Tradition in Islam (New York University Press, 1968).

31 In 762, al'Mansur (754-775) built the new capital. The Persian influence was evident in the powerful royal advisors from the Barmak family, formerly from the province of Bactria, and recent converts to Islam. Nestorian Christian physicians also served at the court. See David Lindberg, *The Beginnings of Western Science: The European Scientific Tradition in Philosophical, Religious, and Institutional Context, 600 B.C. to A.D. 1450.* (Chicago: The University of Chicago Press, 1992), p. 168.

32 The principal translator was an Arab, Hunayn ibn Ishaq (808-873), who came from a family which had converted to Nestorian Christianity before the advent of Islam. He was fluent in Arabic, Syriac, and Greek. .

33 Lindberg, p. 170.

34 Pierre Duhem, "Physics, History of" in *The Catholic Encyclopedia* (1911) 11:48.

35 A.I. Sabra provides a very good sketch of these contributions in "Science, Islamic" in *Dictionary of the Middle Ages* 11:81-88. "Islamic astronomy is a good illustration of the relationship between Islamic and Greek science. Muslim astronomers produced a great deal of very sophisticated astronomical work. The work was carried out largely within the Ptolemaic framework (though we must acknowledge early Hindu influences on Islamic astronomy, largely displaced by subsequent access to Ptolemy's *Almagest* and other Greek astronomical works). Muslim astronomers sought to articulate and correct the Ptolemaic system, improve the measurement of Ptolemaic constants, compile planetary tables based on Ptolemaic models, and devise instruments that could be used for the extension and improvement of Ptolemaic astronomy in general." Lindberg, *op. cit.*, p. 177.

36 The specific debate concerned whether Aristotelian logic transcended the Greek language and was, thus, appropriate to use by those who spoke and wrote in Arabic. See Shehadi, *op. cit.*, pp. 23-4.

37 On al-Farabi, see Ian R. Netton, *Al-Farabi and His School* (London and New York: Routledge, 1992). An excellent survey of Avicenna can be found in the *Encyclopedia Iranica* (Routledge, 1989), Vol. 3, pp. 66-110. Also L. E. Goodman, *Avicenna* (Routledge, 1992).

38 *al-Shifa': al-Ilahiyyat*, VIII.3, translated in Georges Anawati, *La Métaphysique du Shifa'* (Paris, 1978), Vol. II, pp. 83-84. "C'est ce qui veut dire que la chose est créé, 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 par existé eu 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-Shifa': al-Ilahiyyat*, 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.

39 *al-Shifa': al-Ilahiyyat*, VI. 1, quoted in A. Hyman and J. Walsh (eds.), *Philosophy in the Middle Ages*, second edition (Hackett, 1983), p. 248.

40 "Il n'y a donc pas d'autre quiddité (*mahiyya*) pour le nécessairement existant que le fait qu'il est nécessairement existant. Et c'est cel l'être (*al-anniya*)." *al-Shifa': al-Ilahiyyat*, VIII. 4, tranlsated by Georges Anawati, *op. cit.*, Vol. II, p. 87. The classic work on Avicenna's analysis of essence and existence is Amelie-Marie Goichon, *La distinction de l'essence et l'existence d'après Ibn Sina* (Paris, 1937).

41 David Burrell, "Aquinas and Islamic and Jewish Thinkers," in *The Cambridge Companion to Aquinas*, edited by Norman Kretzmann and Eleonore Stump (Cambidge University Press, 1993), p. 69. Georges Anawati, in his introduction to the *Shifa'*, puts it this way: "C'est en partant de l'essence qu'Avicenne aboutit forcément à considérer l'*esse* qui l'affecte comme un accident. S. Thomas par contre part de l'être existant et il fait de l'*esse* ce qu'il y a de plus intime et de plus profond dans cet être." Georges Anawati, *op. cit.*, Vol. 1, p. 78. For an extensive discussion of the "accidentality of existence" in Avicenna, see Shehadi, *op. cit.*, pp. 93-114.

42 Charles Kahn, "Why Existence Does Not Emerge as a Distinct Concept in Greek Philosophy," in *Philosophies of Existence: Ancient and Medieval*, ed. by P. Morewedge (NY: Fordham, 1982), p. 8. "The key to Ibn Sina's synthesis of the metaphysics of contingency with the metaphysics of necessity lies in the simple phrase: *considered in itself*. Considered in itself, each effect is radically contingent. It does not contain the conditions of its own existence; and, considered in itself, it need not exist. Its causes give it being. It is by abstracting from its causes that we can regard even the world as a whole as radically contingent. But considered in relation to its causes, not as something that in the abstract might not have existed, but as something concretely given before us, with a determinate character, the same conditionedness that required us to admit its contingency requires us to admit its necessity. Considered in relation to its causes, this object must exist, in the very Aristotelian sense that it does exist, and must have the nature that it has in that its causes gave it that nature. A thing might *have been* other than as it is, it might yet be other than it is, but it cannot *now* be other than it is." Goodman, *Avicenna*, pp. 66-7.

43 "In one fell swoop, Aquinas has succeeded in restoring the primacy Aristotle intended for individual existing things, by linking them directly to their creator and by granting Avicenna's 'distinction' an unequivocal ontological status. Yet as should be clear, this is more than a development of Avicenna; it is a fresh start requiring a conception of

existing that could no longer be confused with an *accident*, and which has the capacity to link each creature to the gratuitous activity of a free creator. Only in such a way can the radical *newness* of the created universe find coherent expression, for the *existing* 'received from God' will be the source of all perfections and need not presume anything at all -- be it matter or 'possibles.'" David Burrell, "Aquinas and Islamic and Jewish Thinkers," *op. cit.*, pp. 69-70.

44 Avicenna, in his philosophic argumentation, "fused the Aristotelian metaphysics of self- sufficiency with the monotheistic metaphysics of contingency. . . ." Goodman, *Avicenna*, *op. cit.*, p. 63.

45 See Emil l. Fackenheim, "The Possibility of the Universe in Al-Farabi, Ibn Sina, and Maimonides," in *Proceedings of the American Academy of Jewish Research*, Vol. xvi (1947), pp. 39-70; George F. Hourani, "Ibn Sina on Necessary and Possible Existence," in *Philosophical Forum*, 4 (1972), pp. 74-86

46 "It was at this juncture between the Aristotelian givenness and the Scriptural gift of being that Ibn Sina created a third major option in metaphysics, subsuming the creationist contingency of the *kalam* and the essentialist eternalism of Aristotle. Ibn Sina's cosmos, in contrast with Aristotle's, was contingent. But, by contrast with the cosmos of the *kalam*, its contingency did not negate natural necessity, or the efficacy of natural causes and potentialities, including human actions and dispositions. . . . Finite things were contingent in themselves but necessary with reference to their causes and ultimately to God, who is the Cause of causes. Thus the natural order retains its integrity and the continuity of its categories -- time, space, causality, the wholeness of human intelligence, and moral sense." Goodman, *Avicenna,* p. 74.

47 al-Ghazali, *Munqidh*, quoted in L.E. Goodman, *An Introduction to Medieval Islamic Philosophy*, pp. 20-21.

48 *Tahafut al-Falasifah*, discussions 1-4. Goodman summarizes al-Ghazali's central point: "The philosophers [like Avicenna] wanted to show the world's timeless dependence upon God, but the idea of timelessness demands that of self-sufficiency, and Ibn Sina's conception of creation as contingent in itself and necessary with reference to its cause only papers over a contradiction." Goodman, *op. cit.*, p. 83.