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Matter and Spirit in the Universe

Scientific and Religious Preludes to Modern Cosmology

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Introduction:
Cosmo-theology before Einstein

It is sometimes said that there is nothing new under the sun, which is surely an exaggeration. The proverb generally fails miserably in the history of science—after all, to make new discoveries is the business of science, and a quite successful business it is. On the other hand, for centuries astronomy and cosmology have been concerned with essentially the same kind of questions. These can be identified at the time of Kepler, or even earlier, and 350 years later they were still subjects of debate. Some of the problems were these:

(i) Has the world always existed, or did it have an origin? And, will it ever come to an end?
(ii) Is the world finite or infinite in spatial content?
(iii) What is the relationship between the spatial and the material universe?
(iv) Is the world static or in a state of evolution?
(v) From where did matter (and energy) originate? Is it still being created?
(vi) Are the laws of nature, as known from the local environment, applicable to the universe at large?

There are other questions of a similar cosmic nature, some of them even more comprehensive. Thus, philosophers and theologians may want to know *why* the world exists, or why there is something rather

than nothing. Depending on taste and background, this may be considered either a very deep or a very silly question. Most physicists and astronomers will presumably dismiss it as a question that does not belong in the domain of science. Today, several of the questions listed above have received a scientifically based answer, but this clarification only began about World War I, less than a century ago.

Although none of the questions refer to religion, for a long time they have been considered theologically relevant, either because theology might provide the answers, or because the answers might affect theological doctrines. To put it briefly, cosmology has always been important to theology, and, until fairly recently, *vice versa*. The prelude to and early phase of scientific cosmology occurred in the century between 1860 and 1960, largely the period covered by the present work. As we shall see, there was during the period a significant, if also problematic and controversial, interaction between cosmology and religious belief. To put the relationship in perspective, an impressionistic look at a few earlier episodes may be useful.[1]

SCENE I: PARIS 1277

The introduction of Aristotelian learning in European universities in the thirteenth century was of the greatest importance to Christian culture and the emergence of science. But the meeting between Christianity and Aristotelianism was not an easy one, for other reasons because aspects of Aristotle's cosmology seemed to flatly disagree with Christian dogmas. According to Aristotle—respectfully named "the philosopher"—there was only, and could only be, one universe. The world was a plenum, spherically shaped and of limited size. Whereas this was not a great problem to medieval theologians, it was most disturbing that Aristotle had unequivocally argued that the universe could not possibly have come into being, nor could it ever cease to be. In sharp contrast to Genesis, and to Christian belief in general, Aristotle's cosmos was eternal.

This and other heresies in the Aristotelian texts led to heated discussions among the scholastics, who did what they could to present

[1] The literature on the historical relationship between religion and the physical sciences is extensive. For a brief and excellent overview, see Jaki 1966, pp. 412–457.

the admired heathen philosopher in a christianized version. Albert the Great, Thomas of Aquinas and other great theologians of the 13th century sought to circumvent the dilemma of choosing between belief and philosophy, between Jerusalem and Athens. Their answer was a "two roads" philosophy according to which Christian theology and Aristotelian philosophy were different but compatible and supplementary roads to truth. Properly understood the two roads could not lead to contradictory truths. Yet it was hard to see how the strategy could be applied to, for example, the question of whether the world was eternal or created in time. It would seem that if the world is eternal, God could not have created it in the past; conversely, if he did create the world, Aristotle must be wrong.

According to Aquinas, who wrote most of his treatises in the 1260s, the question was more involved than simply a choice between Scripture and Aristotle.[2] In his *De Aeternitatis Mundi* from about 1270, he discussed whether something that had always existed can be made; only if this is logically impossible would he concede that God could not have created an eternal universe. But Aquinas argued that since God need not precede his effects in time, there is no contradiction in claiming that a divinely created universe has always existed. Aquinas granted that all change requires some underlying material reality and that nothing can therefore come from nothing. Yet, whereas philosophers deal with changes or processes such as found in the physical world, theologians are concerned with creation, a very different notion which centers on existence as such. Creation is not merely change, it is to give existence to things, to cause them. God does not take "nothing" and transforms it into something, he causes things to exist continually in the radical sense that if they were left to themselves they would return to nothingness.

From this perspective there is no real distinction between creation and preservation. Applying his reasoning to cosmology, Aquinas distinguished between a temporal beginning of the universe and its creation, where the latter concept refers to the existence of the universe as such. From this point of view an eternal, created universe is perfectly possible. Even if the universe had no temporal beginning, it would still depend upon God for its very being. Aquinas repeatedly

[2] Carroll 1998 (and on www.nd.edu/Departments/Maritain/ti/carroll.htm).

stressed that creation is a metaphysical, not a temporal concept:

> Not only does faith hold that there is creation, but reason also demonstrates it … . It is 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 … . 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 a 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 is has from something else.[3]

Aquinas thought that Aristotle was wrong to contend that the universe is eternal, but he also argued that the question could not be answered on the basis of reason or science alone. As a Christian he believed that the universe was of finite age, but it might well be eternal from a philosophical point of view. What really mattered was that God had created the universe, given it existence, and this involved no contradiction with either reason or faith.

Aquinas was professor in Paris in two periods, 1256–59 and 1269–72. In spite of his elaborate attempt to steer a middle course between Aristotle and Catholic faith, the tensions reached a climax soon after his death. In 1277, the Bishop of Paris, Etienne Tempier, issued a list of forbidden propositions, opinions which were condemned as heretical. Altogether there were 219 such false propositions, including "That the only wise men of the world are philosophers" (where "philosopher" may also be understood to mean "scientist"). Some of the propositions referred to cosmology, such as the erroneous belief in a cyclical universe, "That when all celestial bodies have returned to the same point—which will happen in 36,000 years—the same effects now in operation will be repeated." The Bishop also made clear that God could have made several worlds, had he so wished. Moreover, it was wrong to believe

> (87) That the world is eternal as to all species contained in it; and that time is eternal, as are motion, matter, agent, and

[3] *Ibid.*

> recipient .... (107) That the elements are eternal. However, they have been made anew in the relationship they now have .... (185) That it is not true that something could be made from nothing, and also not true that it was made in the first creation .... (202) That the elements have been made in a previous generation from chaos; but they are eternal.[4]

In spite of the problems of reconciling Christian faith and the naturalistically oriented philosophy (or science), the ingenious Thomist synthesis did what might seem impossible. In 1323 Aquinas was canonized, and two years later the bishop of Paris revoked the condemned articles. Theology and natural philosophy appeared to have entered a harmonious partnership. Aquinas' system eventually became part of official Catholicism, especially after Pope Leo XIII in 1879 called attention to it as an answer to the intellectual and social challenges of modernity. Since then, Thomism and neo-Thomism have been integrated elements in Catholic thinking.

That medieval philosophers were not always restricted by theological doctrines is illustrated by Nicholas of Cusa, better known as Cusanus, who in *De Docta Ingorantia* from 1440 argued for an infinite and homogeneous universe. According to Cusanus, there was no privileged place in the universe, and all celestial bodies were essentially of the same nature. His radical postulate anticipated what in twentieth-century cosmology became the cosmological principle, the claim that the universe at large is homogeneous and isotropic.

Some of Cusanus' ideas were later developed by Giordano Bruno, who not only suggested that the world is spatially infinite but also that it is eternal. Understandably, his ideas led him into trouble with the Church.

Thomas Aquinas and his contemporaries were principally concerned with theology, not the physical universe, and one may wonder what the learned discussions in the 13th century has to do with modern cosmology. The answer, it seems to me, is: quite a lot. As we shall see in Chapter 6, the distinctions made by medieval theologians were highly relevant to the cosmological controversy in the 1950s. They still are.

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[4] Quoted from the selection in Grant 1974, pp. 48–50.

SCENE II: THE NETHERLANDS 1637

In the early part of the 17th century the relationship between science and theology was still strong, perhaps stronger than ever, but it was no longer harmonious. In particular, Copernicus' heliocentric world system of 1543 caused problems with Christian orthodoxy. In 1633 Galileo had been condemned by the Roman-Catholic church, imprisoned and forced to retract his heretical support of the Copernican universe which so obviously contradicted the Holy Writ. René Descartes, the new star on the firmament of natural philosophy, was shocked, and decided to withhold from publication his *Le Monde*, a cosmology firmly based upon Copernican principles. As he wrote to Marin Mersenne, "I wouldn't want to publish a discourse which had a single word that the Church disapproved of; so I prefer to suppress it rather than publish it in a mutilated form."[5] Descartes was no more an atheist, a materialist or an agnostic (a word still to be invented) than Galileo was. He believed in God as the creator of the universe, but not in a universe which developed according to some plan, teleologically towards the present state of affairs. Descartes' cosmological vision was different, such as he made it clear in his famous *Discours de la Méthode* of 1637, published anonymously in Leiden.

Descartes is one of the fathers of the very idea of natural laws, and he strongly believed not only that law-governed mechanical processes had to replace teleology, but also that his picture of the world was in full agreement with Christian belief. Ultimately, his cosmogony and cosmology were products of matter in motion. God had of course installed the laws, as he had created the material world, but that was that. What followed was a consequence of the laws of motion and the initial conditions. However, in *Discours* and elsewhere he argued that the laws were all-important, not the special initial conditions. These could be anything. What would happen, he asked, if God created a new world and "if He agitated in diverse ways, and without any order, the diverse portions of this matter, so that there resulted a chaos as confused as the poets ever feigned, and concluded His work by merely lending His concurrence to Nature in the usual way, leaving her to act in accordance with the laws which

[5] Quoted in Gaukroger 1995, p. 291.

He had established."[6] According to Descartes, who immodestly claimed his reasoning to rest on no "other principle than the infinite perfection of God," the mechanical laws would eventually lead to the very same world that we inhabit:

> Although He had not, to begin with, given this world any other form than that of chaos, provided that the laws of nature had once been established and that He had lent His aid in order that its action should be according to its wont, we may well believe, without doing outrage to the miracle of creation, that by this means alone all things which are purely material might in course of time have become such as we observe them to be at present.

That is, cosmic development is strictly determined by the laws of nature, and there is no further need for God to intervene with any supplementary acts of creation. Descartes effectively limited the omnipotent God's cosmic creativity, not with respect to worlds or matter but to the laws of nature. These, he wrote, "are of such a nature that even if God had created other worlds, He could not have created any in which these laws would fail to be observed." It was not the last time that a cosmologist argued that the divine laws of nature are not subject to God's further manipulation (see Chapter 6).

Descartes believed that the most efficient way to construct a universe would also be God's way, and this way was to start with a chaos and invoke only the laws of mechanics. Any kind of original chaos would do, as it would lead to the same world. What has been called the "indifference principle" was however initially seen as theologically suspect, because it was too mechanistic and seemed to make natural theology redundant. In modern cosmological theory the indifference principle has reappeared in so-called chaotic cosmology and models of the very early, inflationary universe.[7]

SCENE III: CAMBRIDGE 1692

The first edition of Newton's *Principia*, published in 1687, was silent about God and also included no discussions of cosmological and

[6] Descartes 1996, pp. 26–28.
[7] McMullin 1993.

cosmogonical questions. These only entered in the second edition of 1713, where Newton declared that "to treat of God from phenomena is certainly a part of natural philosophy." His scientific arguments for the existence of God were essentially of two types. For one thing, the wonderful richness and organization of the universe strongly indicated that it was designed by a divine being. In addition to this argument of natural theology, Newton mentioned various phenomena that could not be explained scientifically and therefore required appeal to divine intervention. This was an argument of what would later be called "God of the gaps." Newton wrote:

> This most elegant system of the sun, planets, and comets could not have arisen without the design and dominion of an intelligent and powerful being. And if the fixed stars are the centers of similar systems, they will all be constructed according to a similar design and subject to the dominion of *One*, … . And so that the systems of the fixed stars will not fall upon one another as a result of their gravity, he has placed them at immense distances from one another.[8]

But even though God originally ordered the stars at immense distances, in itself this would be insufficient to prevent gravitational collapse. God had created the stellar system and his further action was required to preserve it.

Newton's thinking about cosmological problems was indebted to a series of questions from Richard Bentley, chaplain to the Bishop of Worcester. In his correspondence with Bentley in the winter 1692–93, Newton mentioned several astronomical phenomena that could be accounted for only by assuming God's direct intervention. For example, "the Motions which the Planets now have could not spring from any natural Cause alone, but were impressed by an intelligent Agent;" and the adjustment of the velocities, masses and distances of the planets "argues that Cause to be not blind and fortuitous, but very well skilled in Mechanicks and Geometry."[9] The present course of nature could not go on indefinitely. If left to herself, nature would slowly enter a state of decay because of the celestial bodies' friction in the ether and their mutual gravitational perturbations.

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[8] Newton 1999, p. 940. On Newton's cosmo-theology, see Hoskin 1982, pp. 71–100.
[9] Newton's letters to Bentley, first published in 1756, are reproduced in Cohen 1978, pp. 279–312.

As to the distribution of matter in the universe, Newton argued that if the world was finite all matter would eventually coalesce in one huge central mass. Even in his favoured universe of infinite size it was hard to imagine how the stars could be arranged in a perfect gravitational equilibrium, but Newton thought it was possible, "at least by a divine power." In his *Confutation of Atheism* of 1693, Bentley repeated what Newton had taught him: "The continuance of this Frame and Order for so long a duration as the known ages of the World must necessarily infer the Existence of God. For though the Universe was Infinite, the Fixt Starrs could not be fixed, but would naturally convene together, and confound System with System."[10] For Newton and Bentley it was important to stress that although the force of gravitation operates throughout the infinite universe, neither it nor other known laws of nature can secure a stable universe. Only divine providence can do that. In his third letter to Bentley, Newton considered the possibility "that there might be other Systems of Worlds before the present ones, and others before those, and so on to all past Eternity." Although he dismissed such a self-generating cyclical universe as "apparently absurd," he granted that it might be accomplished by the will of a divine power.[11]

Newton returned to cosmo-theology in Query 31 of his *Opticks*, where he concluded that it was most "unphilosophical" to believe that the world "might arise out of a Chaos by the mere Laws of Nature." Contrary to Descartes, Newton insisted that the universe cannot be fully understood by the laws of mechanics alone. The wonderful uniformity in the planetary and siderial systems was only possible because they were constructed and maintained by an intelligent agent. Newton's universe was mechanical but neither deterministic nor free of vital principles and spirits. On the contrary, such non-mechanical principles were all-important to keep the universe going, for "Motion is more apt to be lost than got, and is always upon the Decay." In a passage which may bring to mind much later discussions concerning possible counter-entropic processes, he wrote: "If it were not for these Principles, the Bodies of the Earth, Planets, Comets, Sun, and all things in them, would grow cold and freeze, and

[10] Cohen 1978, p. 351.
[11] On Newton and the cyclical universe, see Kubrin 1967, reprinted in Colin A. Russell, *Science and Religious Belief. A Selection of Recent Historical Studies* (Guildford: Open University Press, 1979), pp. 147–169.

become inactive Masses; and all Putrefaction, Generation, Vegetation and Life would cease, and the Planets and Comets would not remain in their Orbs."[12]

Whereas Descartes' God was constrained by the laws of nature, Newton emphasized God's omnipotence and absolute freedom to create whatever he pleased. The laws of nature were expressions of the way God acted and he could decide to act differently, thereby changing the laws. In *Opticks*, Newton indulged in a remarkable many-worlds speculation. "It may be also allow'd," he wrote, "that God is able to create Particles of Matter of several Sizes and Figures, and in several Proportions to Space, and perhaps of different Densities and Forces, and thereby to vary the Laws of Nature, and make Worlds of several sorts in several Parts of the Universe."[13]

To Leibniz and other critics, the universe created by Newton's God looked suspiciously like a second-rate construction in constant need of repair. They believed that a perfect God would have created a perfect world, at least in the sense of being the best of all possible worlds, a machine in no need of maintenance. But Newton and his protagonists found such a world view to be dangerously close to deism. Samuel Clarke, Newton's spokesman in the controversy with Leibniz, expressed it as follows: "The notion of the world's being a great machine, going on without the interposition of God, as a clock continues to go without the assistance of a clockmaker, is the notion of materialism and fate, and tends … to exclude providence and God's government in reality out of the world."[14]

Leibniz was no less obsessed with God than Newton was. But he conceived of God differently, and his arguments for His existence were different too. For example, Leibniz asked why there is something rather than nothing, and also why things exist as they do and not in some other form. There must, he wrote, be a "sufficient reason, which needs no further reason, must be outside this series of contingent things, … . And this final reason of things is called God."[15] Leibniz's argument is one version among several which are collectively known as the cosmological argument (and which has nothing to do with cosmology in its modern meaning).

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[12] Newton 1952, pp. 399–402.
[13] *Ibid.*, pp. 403–404.
[14] Quoted in Hoskin 1982, p. 88.
[15] Leibniz 1934, p. 26.

SCENE IV: KÖNIGSBERG 1755

Immanuel Kant, a young privatdocent at the University of Königsberg in Prussia, published in 1755 a remarkable work on the development and structure of the universe, *Allgemeine Naturgeschichte und Theorie des Himmels*. Unfortunately his publisher went bankrupt and had his stock impounded, for which reason the work remained practically unknown for a long time. It was only after Helmholtz had praised the theory in a lecture delivered at Königsberg in 1854, that it came to general attention.[16] In spite of its lack of impact, Kant's book marked a new phase in the history of cosmology, primarily because it presented a thoroughly *evolutionary* account of the universe in its totality. It was a grand attempt at a *Universal Natural History and Theory of the Heavens*, as the title reads in English. His world picture was purportedly a scientific theory, solidly based on Newtonian mechanics, but it was a qualitative picture only, and one that rested to a large extent on speculations and hypotheses. Although Kant referred frequently to God and presented his theory as theistic, in reality it was naturalistic, and the references to the Creator largely rhetorical. Contrary to Newton, but in agreement with Leibniz, he found no place for divine miracles in the universe: "A constitution of the world which did not maintain itself without a miracle, has not the character of that stability which is the mark of the choice of God."[17]

Kant started with an original, divinely created chaos of particles at rest, distributed throughout an infinite void. This initial chaos is unstable, he said, and the denser particles will begin to attract the more tenuous, and thus form condensations. With Descartes he claimed that the primary chaos must necessarily evolve into regular and orderly structures—a definite cosmos. As a result of Newtonian gravitation, repulsive forces and collisions, bodies were formed in orbital motion around centers of attraction. In this way he claimed to be able to explain the formation of the solar system, and went on to generalize his system of formation to still larger structures. His great insight was that the Milky Way has a disk-like structure, that it is a flattened conglomerate of a multitude of stars encircling a center.

[16] Helmholtz 1995, pp. 18–45. Helmholtz quoted parts of Genesis and suggested that its account of the creation of the world was consonant with Kant's scenario of a chaos transforming into a cosmos.
[17] Kant 1969, p. 141.

Even more innovatively, he suggested that the nebulous stars were not individual stellar objects, but vast congeries of stars of the same type and structure as the Milky Way. And the enormous nebulae (or galaxies) would themselves be members of even larger structures, the hierarchical arrangement continuing indefinitely throughout the infinite depths of the universe.

Infinitude, evolution and creation were key notions in Kant's dynamical cosmology. He found it imperative that the world must be infinite in space, as only such a universe accords with the attributes of God. "Eternity is not sufficient to embrace the manifestations of the Supreme Being, if it is not combined with the infinitude of space." But God had not created the world in its present state; it had slowly evolved from the primeval chaos governed by the laws of nature: "The arrangement and institution of the universe comes about gradually, as it arises out of the provision of the created matter of nature in the sequence of time."[18]

Kant's cosmic creation was anything but creation once and for all. He wrote of the creation process as a sort of wave propagating from a central area of the universe, bringing life, activity and organization with it. "The sphere of developed nature is incessantly engaged in extending itself. Creation is not the work of a moment…. Millions and whole myriads of millions of centuries will flow on, during which always new worlds and systems of worlds will be formed…. The creation is never finished or complete. It has indeed once begun, but it will never cease."[19]

In Kant's vision, destruction was no less important than creation. Entire worlds perish and are "swallowed up in the abyss of eternity," but in the same time destruction is counteracted by creative processes from which new cosmic formations result. It is in the very nature of finite things, however big, that they will eventually decay. "But we ought not to lament the perishing of a world as a real loss of nature…. The infinitude of the creation is great enough to make a world, or a Milky Way of worlds, look in comparison with it, what a flower or an insect does in comparison with the earth."

Kant even speculated that the entire world, or parts of the world, might return to a chaotic state and then re-emerge, possibly an

[18] *Ibid.*, p. 140.
[19] *Ibid.*, pp. 145–146.

infinity of times. "Can we not believe that Nature, which was capable of developing herself out of chaos into a regular order and into an arranged system, is likewise capable of re-arranging herself again as easily out of the new chaos into which the diminution of her motions has plunged her, and to renew the former combination?" Kant had no problem with believing such a scenario of "this Phoenix of nature, which burns itself only in order to revive again in restored youth from its ashes, through all the infinity of times and spaces."[20] In this endless cycle of processes, God played no role.

Kant was only 31 years old when he published the ill-fated *Allgemeine Naturgeschichte*. In his later career he came to doubt not only if the design of the universe had anything to do with the existence of God, but also if the notions of age and extent were meaningful when applied to the universe as a whole. In his famous *Kritik der Reinen Vernunft* of 1781, he concluded that the universe cannot be an object of knowledge, and consequently, that cosmology as a science is impossible.

William Herschel was not acquainted with Kant's work, but in some respects his approach to astronomy and cosmology corresponded to that of the philosopher in Königsberg. Astronomy was for Herschel a historical science, a natural history of the heavens. In a remarkable series of papers starting in 1785 and carrying the common title "The Construction of the Heavens" he developed the perspective in a far more fruitful way than Kant. Inspired by Newton, Herschel realized the tendency towards decay and destruction in the universe, yet he was confident that "the great Author of it has amply provided for the preservation of the whole." In perfect agreement with Kant he did not lament "the destruction of now and then a star, in some thousands of ages," for the destructive processes might be the very means by which the universe is preserved and renewed. With a happy phrase he called clusters of stars "the laboratories of the universe."[21]

Herschel's cosmos was not only big; it was "fathomless." With important insight he realized that by observing nebulae very far away he would also observe the distant past of the universe. The temporal and spatial dimensions of the universe were connected by

[20] *Ibid.*, pp. 153–154.
[21] Hoskin 1963, p. 85.

the finite velocity of light, which meant that observational cosmology was necessarily historical in nature. Although the astronomer could not follow directly the slow evolution of stars and nebulae, he could construct an evolutionary picture of the universe by collecting data from different parts of it, some far away and others closer to earth. In a paper from 1789, the year of the French revolution, he expressed it beautifully:

> They [the heavens] now are seen to resemble a luxuriant garden, which contains the greatest variety of productions, in different flourishing beds; and one advantage we may at least reap from it is, that we can, as it were, extend the range of our experience to an immense duration. For,… is it not almost the same thing, whether we live successively to witness the germination, blooming, foliage, fecundity, fading, withering, and corruption of a plant, or whether a vast number of specimens, selected from every stage through which the plant passes in the course of its existence, be brought at once to our view?[22]

[22] *Ibid.*, p. 115.