3 Qualified Agreement
Modern Science & the Return of the "God Hypothesis"

Stephen C. Meyer

And thus much concerning God;
to discourse of Whom from the appearances of things,
does certainly belong to Natural Philosophy.
SIR ISAAC NEWTON

Part 1: Introduction

Alfred North Whitehead said that "when we consider what religion is for mankind and what science is, it is no exaggeration to say that the future course of history depends upon the decision of this generation as to the relations between them."[1] Whitehead spoke early in the twentieth century at a time when most elite intellectuals believed that science contradicted classical theism with its traditional belief in a divine creation, the uniqueness of humanity and the immortality of the soul. For many intellectuals a scientifically informed worldview was a materialistic worldview in which entities such as God, free will, mind, soul or purpose could play no objective role. Scientific materialism denied evidence of any intelligent design in nature and any ultimate purpose to human existence. As Whitehead's contemporary Bertrand Russell put it, "Man is the product of causes which had

[1]Alfred North Whitehead, *Science and the Modern World* (New York: Macmillan, 1926), p. 260.

no prevision of the end they were achieving" and that predestine him "to extinction in the vast death of the solar system."[2]

It is not hard to see why many intellectuals held this opinion. Over the previous two hundred years Western science and philosophy had witnessed a profound shift away from its earlier Judeo-Christian orientation. Starting in the Enlightenment many philosophers began to deny the validity of the classical proofs for God's existence from nature. Philosophers such as David Hume and Immanuel Kant raised powerful objections to the design argument and the cosmological argument, the two most formidable theistic arguments of this kind.

Further, despite the now well-documented influence of Judeo-Christian thinking on the rise of modern science from the time of Ockham to Newton,[3] much of science took a decidedly materialistic turn. In astronomy the French mathematician Laplace offered an ingenious theory known as the nebular hypothesis to account for the origin of the solar system as the outcome of purely natural gravitational forces. In geology Charles Lyell explained the origin of the earth's most dramatic topographical features—mountain ranges and canyons—as the result of slow, gradual and completely naturalistic processes of change. In cosmology a belief in the infinity of space and time obviated any need to consider the question of the ultimate origin of matter. Perhaps most significantly, Darwin's evolutionary theory sought to show that the blind process of natural selection acting on random variations could and did account for the origin of new forms of life without any divine intervention or guidance. According to Darwin living organisms only *appeared* to be designed by an intelligent creator; nature itself was the real creator.[4] As Francisco Ayala has explained, "The functional design of organisms and their features would . . . seem to argue for the existence of a designer. It was Darwin's greatest accomplishment to show that the directive organization of living beings can be explained as the result of a natural process, natural selection, without any need to resort to a Creator or other external agent."[5]

[2]Bertrand Russell, quoted in James B. Conant, *Modern Science and Modern Man* (New York: Doubleday/Anchor, 1953), pp. 139-40.

[3]R. Hooykaas, *Religion and the Rise of Modern Science* (Grand Rapids, Mich.: Eerdmans, 1972); P. E. Hodgson, review of S. L. Jaki's *Science and Creation* in *Nature* 251 (October 1974): 747; A. N. Whitehead, *Science and the Modern World* (New York: Free Press, 1967), pp. 3-4, 12-13; Loren Eisley, *Darwin's Century: Evolution and the Men Who Discovered It* (Garden City, N.Y.: Anchor, 1961), p. 62; Herbert Butterfield, *The Origins of Modern Science 1300-1800* (New York: Free Press, 1957), pp. 16-17, 19; M. B. Foster, *Mind* 43, no. 172 (1934): 446; C. F. von Weizsacker, *The Relevance of Science* (New York: Harper & Row, 1964) p. 163; Nancy R. Pearcy and Charles B. Thaxton, *The Soul of Science* (Wheaton, Ill.: Crossway, 1994), pp. 17-42, 43-56.

[4]Charles Darwin, *The Origin of Species* (London: Penguin, 1985).

These theories taken jointly suggested that the whole history of the universe could be told as a seamless, or nearly seamless, unfolding of the potentiality of *matter and energy*. Science seemed to support a materialistic or naturalistic worldview, not a theistic one. Science no longer needed to invoke a preexistent mind to shape matter in order to explain the evidence of nature. Matter had always existed and could—in effect—arrange itself without a preexistent designer or Creator. Thus by the close of the nineteenth century both the logical and evidential basis of theistic arguments from nature had seemingly evaporated.

The demise of theistic arguments from nature and the corresponding rise of a scientifically based materialistic worldview fostered a profound shift in the way thinking people conceptualized the relationship between science and Christian faith. Many scientists, philosophers and even theologians during the twentieth century began to perceive science and Christianity as standing in conflict with one another. Others, however, denied that science contradicts Christian belief. Nevertheless, they have typically done so by portraying science and religion as such totally distinct enterprises that their teachings do not intersect in significant ways. Two such models, independence (or compartmentalism) and complementarity (or "partnership," to use Van Till's term),[6] are discussed in the introduction to

[5]Francisco J. Ayala, "Darwin's Revolution," in *Creative Evolution?!* ed. John H. Campbell and J. William Schopf (Boston: Jones & Bartlett, 1994), p. 4.

[6]Michael Peterson provides a helpful threefold typology of perceived relationships between science and religion in *Reason and Religious Belief* (Oxford: Oxford University Press, 1989), pp. 196-216. Peterson discusses the conflict, compartmentalism and complementarity models of science and religion interaction. He does not, however, consider the possibility that scientific evidence might support theistic belief, though that remains a logical possibility. I have, therefore, proposed (and am defending here) a fourth model called "qualified agreement" or "epistemic support." See Stephen C. Meyer, "The Demarcation of Science and Religion," in *The History of Science and Religion in the Western Tradition: An Encyclopedia*, ed. Gary Ferngren, Edward Larson and Darrel W. Amundsen (New York: Garland, 2000), pp. 17-23; William A. Dembski and Stephen C. Meyer, "Fruitful Interchange or Polite Chit-Chat? The Dialogue Between

this book. Both these models assume the religious and metaphysical neutrality of scientific knowledge.[7] Thus, some have seen the witness of science as hostile to theistic and Christian faith, while others have attempted to cast it as entirely neutral. Few, however, have thought—in contrast to the founders of early modern science such Kepler, Boyle and Newton—that the testimony of nature (i.e, science) actually supports important tenets of a theistic or Christian worldview.

This essay will reassert this classical view and argue that scientific evidence does provide epistemological support (but not proof) for the theistic worldview affirmed by biblical Christianity (see Acts 17; Rom 1; Col 1, for example). It will develop a model of the relationship between science and Christianity that I call "qualified agreement" or "mutual epistemic support." This model maintains that, when correctly interpreted, scientific evidence and biblical teaching can and do support each other. Though advocates of qualified agreement acknowledge (with independence and complementarity advocates) that much scientific research and theorizing *does* address metaphysically and religiously neutral topics, we do not agree that *all* scientific theories have this character. Instead, the qualified agreement model, like the conflict model, asserts that some scientific theories do have larger metaphysical implications. Nevertheless, unlike the conflict model, qualified agreement denies that the best or most truthful theories ultimately contradict a theistic or Christian worldview. Instead, it views theological and scientific truth as issuing from the same transcendent and rational source, namely, God. Advocates of qualified agreement anticipate therefore that these two domains of knowledge when rightly understood and interpreted will come increasingly into agreement as advances in science and theology eliminate real points of conflict that sometimes have existed.

Because many of the founders of early modern science held this view (though with a less-nuanced justification, perhaps), we might also refer to

Science and Theology," *Zygon* 33, no. 3 (1998): 415-30.

[7]Donald M. MacKay, *The Clockwork Image* (Downers Grove, Ill.: InterVarsity Press, 1974), pp. 51-55; Howard Van Till, *The Fourth Day* (Grand Rapids, Mich.: Eerdmans, 1986), pp. 208-15; Howard Van Till, Davis Young and Clarence Menninga, *Science Held Hostage* (Downers Grove, Ill.: InterVarsity Press, 1988), pp. 39-43, 127-68. See also Oskar Gruenwald, "Science and Religion: The Missing Link," *Journal of Interdisciplinary Studies* 6 (1994): 1-23, for a different interpretation of complementarity that affirms methodological autonomy of science and religion but conjoins their findings.

this model as the "classical" formulation of the relationship between science and religion. Indeed, from the late Middle Ages through the scientific revolution (roughly 1250-1750) scientists often affirmed the agreement between "the book of nature" and "the book of scripture," both of which were understood to be mutually reinforcing revelations of the same God.

I will reformulate this view by showing that contemporary scientific evidence from cosmology, physics and biology now supports a theistic worldview. I will also provide a more refined notion of epistemological support. Many thinkers, both theistic and naturalistic, have assumed that science supports a Christian or theistic worldview only if it can provide the basis for a deductively certain proof of God's existence. I will show how evidence from the natural sciences can and does provide epistemological support for Christian theism even if it does not make possible such a deductively certain proof. I will first, however, examine how the demise of theistic arguments from nature helped undermine the classical view of the relationship between science and Christian faith.

Part 2: The Rise and Fall of Theistic Arguments

Two types of arguments from nature for God's existence have proven especially effective in the history of Western thought: design and cosmological arguments. The classical design argument begins by noting certain highly ordered or complex features within nature, such as the configuration of planets or the architecture of the vertebrate eye. It then proceeds to argue that such features could not have arisen without the activity of a preexistent intelligence (which has typically been equated with God). The cosmological argument starts from the existence and causal regularity of the universe and seeks to deduce a necessary being—that is, God—as the first cause or sufficient reason for the universe's existence.[8] Perhaps the most empirically contingent version of the argument, the *kalam* cosmological argument, asserts that the universe had a temporal beginning—a proposition that medieval philosophers typically sought to justify by showing the logical or mathematical absurdity of an infinite regress of cause and effect. The argument then concluded that the beginning of the physical universe must

[8]William Lane Craig, *Reasonable Faith* (Wheaton, Ill.: Crossway, 1994), pp. 79-83.

have resulted from an uncaused first cause (God) that exists independently of the universe.[9] Throughout Western history many philosophers and scientists formulated various empirically based theistic arguments. Consequently, many also viewed science and theistic belief as mutually reinforcing. Yet many important versions of these arguments came into disrepute by the end of the nineteenth century, chiefly due to developments within science.

2.1. Classical Design Arguments

A survey of Western thought reveals theistic design arguments in the writings of Christian and non-Christian writers alike. Among non-Christians, design arguments are found in the work of Greek philosophers such as Plato, Roman philosophers such as Cicero and Jewish theologians such as Maimonides.[10] The Roman philosopher Cicero formulated a sophisticated version of the design argument[11] that anticipated by almost two thousand years the later work of William Paley.

Design arguments are also found in the writings of early Christian theologians including Basil the Great, Gregory of Nazianzus, Theophilus of Antioch, Minucius Felix and Augustine. During the latter Middle Ages thinkers such as Roger Bacon, Robert Grosseteste, Duns Scotus, William of Ockham and Thomas Aquinas formulated their ideas about science in the context of an explicitly Christian philosophy of nature that either presupposed or provided arguments for the existence of a transcendent Designer and Creator.

Support for the design hypothesis did not abate during the period of the

[9]William Lane Craig, *The Cosmological Argument from Plato to Leibniz* (London: Macmillan, 1980), pp. x, xi, 48-126, 158-204, 282-95; Craig, *Reasonable Faith,* pp. 79-80; Richard Swinburne, *The Existence of God* (Oxford: Clarendon, 1979), pp. 116-32.

[10]Plato, *The Laws,* trans. A. E. Taylor (London: Dent, 1969), p. 279; Cicero, *De Natura Deorum,* trans. H. Rackham (Cambridge, Mass.: Harvard University Press, 1933), pp. 217-19.

[11]In his *De Natura Deorum* Cicero (45 B.C.) writes, "When we see something moved by machinery, like an orrery or clock . . . we do not doubt that these contrivances are the work of reason; when therefore we behold the whole compass of heaven moving with revolutions of marvelous velocity and executing with perfect regularity the annual changes of the seasons with absolute safety and security for all things, how can we doubt that all this is effected not merely by reason, but by a reason that is transcendent and divine?" (ibid.)

scientific revolution (1500-1700).[12] Many of the founders of early modern science assumed that the natural world was intelligible precisely because they also assumed that it had been designed by a rational mind. In addition, many individual scientists—Johannes Kepler (1571-1630) in astronomy,[13] John Ray (1627-1705) in biology,[14] Robert Boyle (1627-1691) in chemistry[15]—made specific design arguments based upon discoveries in their respective fields. This tradition attained an almost majestic rhetorical quality in the writing of Isaac Newton (1642-1727). In the general scholium to the *Principia,* Newton suggested that the stability of the planetary system depended not only upon the regular action of universal gravitation but also upon the very precise initial positioning of the planets and comets in relation to the sun. As he explained:

> Though these bodies may, indeed, persevere in their orbits by the mere laws of gravity, yet they could by no means have at first derived the regular position of the orbits themselves from those laws. . . . [Thus] this most beautiful system of the sun, planets, and comets, could only proceed from the counsel and dominion of an intelligent and powerful being.[16]

Or as he wrote in the *Opticks:*

> How came the Bodies of Animals to be contrived with so much Art, and for what ends were their several parts? Was the Eye contrived without

[12]Neal Gillespie, "Natural History, Natural Theology, and Social Order: John Ray and the Newtonian Ideology," *History of Biology* 20, pt. 1 (1987): 1-49.

[13]See, e.g., chapter two of Johannes Kepler, *Mysterium Cosmographicum (The Secret of the Universe)* (New York: Abaris, 1981), pp. 93-101; and his *Harmonies of the World* bk. 5 (Amherst, N.Y.: Prometheus, 1995), pp. 170, 240-45. That Kepler believed that the work of God is evident in nature can been seen by his statement in the *Harmonies of the World* that God "by the light of nature promote[s] in us the desire of the light of grace, that by its means [God] mayest transport us into the light of glory" (Kepler, *Mysterium Cosmographicum,* p. 240). See also Morris Kline, *Mathematics: The Loss of Certainty* [New York: Oxford University Press, 1980], p. 39).

[14]John Ray, *The Wisdom of God Manifest in the Works of Creation,* 3rd ed. (London: Printed for Smith and Walford, at the Prince's Arms in St. Paul's Church-yard, 1701).

[15]Robert Boyle, *Selected Philosophical Papers of Robert Boyle,* ed. M. A. Stewart (New York: Macmillan, 1979), pp. 172-74.

[16]Isaac Newton, *Mathematical Principles of Natural Philosophy* (Berkeley: University of California Press, 1960), pp. 543-44.

> Skill in Opticks, and the Ear without Knowledge of Sounds? . . . And these things being rightly dispatch'd, does it not appear from phaenomena that there is a Being incorporeal, living, intelligent, omnipresent[?][17]

For Newton and other like-minded early modern scientists, observable evidences in nature testified to an unobservable and intelligent Designer whom they identified with the God of the Judeo-Christian Bible.

2.2. The Demise of the Design Argument

With the advent of the Enlightenment both Judeo-Christian belief and the design argument came under attack. For example, the skeptical empiricist philosopher David Hume (1711-1776) rejected the existence of God and the validity of the design argument.[18] Hume maintained in his *Dialogues Concerning Natural Religion* (1779) that the design argument depended upon a flawed analogy with human artifacts. He admitted that biological organisms have certain similarities to complex human artifacts. Eyes and pocket watches both depend on the functional integration of many separate and specifically configured parts. Nevertheless, he argued, biological organisms also differ from human artifacts—they reproduce themselves, for example—and the advocates of the design argument fail to take these dissimilarities into account. Since experience teaches that organisms always come from other organisms, Hume argued that analogical argument really ought to suggest that organisms ultimately come from some primeval organism, not a transcendent mind or spirit. Hume also argued that arguments about the design of the universe as a whole depend on a flawed induction. Inductive reasoning, Hume argued, depends on repeated experience. Since the universe as a whole belongs to a class of one, we can make no inferences about the causes of universes in general or, therefore, about our universe in particular.

Despite these objections, Hume's categorical rejection of the design argument did not prove decisive with either theistic or secular philosophers. Thinkers as diverse as the Scottish Presbyterian Thomas Reid (1710-1796)

[17]Isaac Newton, *The Opticks, Book Three, Part One, Query 28* (New York: Dover, 1952), pp. 369-70.

[18]See David Hume, *Dialogues Concerning Natural Religion* (Buffalo, N.Y.: Prometheus, 1989), pp. 61-66.

and the Enlightenment deist Thomas Paine continued to affirm the validity of the design argument because of the order they perceived in nature.[19] Even Immanuel Kant (1724-1804), who rejected the design argument as a proof of the transcendent and omnipotent God of Judeo-Christian theology, still accepted the conclusion that it could establish the reality of a powerful and intelligent author of the world. In his words, "physical-theological argument can indeed lead us to the point of admiring the greatness, wisdom, power, etc., of the Author of the world, but can take us no further."[20] Kant sought to limit the scope of the design argument but did not reject it wholesale.

In any case, science-based design arguments continued into the early nineteenth century, especially in biology. William Paley's (1743-1805) *Natural Theology,* published in 1803 (several years after Hume's criticism of the design argument), is the most notable example. Paley's work cataloged a host of biological systems that suggested the work of a superintending intelligence. He argued that the astonishing complexity and superb adaptation of means to ends in such systems could not originate strictly through the blind forces of nature anymore than could a complex pocket watch.

Paley also responded directly to Hume's claim that the design inference rested upon a faulty analogy. A watch that could reproduce itself, he argued, would constitute an even more marvelous effect than one that could not.[21] Thus, for Paley the differences between artifacts and organisms that Hume cited only seemed to strengthen the conclusion of the design argument. And indeed, despite the widespread currency of Hume's objections, many scientists continued to find Paley's watch-to-watchmaker reasoning compelling well into nineteenth century.

Thus it was not ultimately the arguments of the philosophers that destroyed the popularity of the design argument but the emergence of increasingly powerful materialistic explanations of apparent design, particularly Charles Darwin's theory of evolution by natural selection. Darwin argued in 1859 that living organisms only appeared to be designed. Darwin proposed a specific mechanism, natural selection acting on random varia-

[19]Thomas Paine, *The Life and Works of Thomas Paine,* vol. 8: *The Age of Reason* (New Rochelle, N.Y.: Thomas Paine National Historical Association, 1925), p. 6.

[20]Immanuel Kant, *Critique of Pure Reason,* trans. Norman Kemp Smith (London: Macmillan, 1963), p. 523.

[21]William Paley, *Natural Theology* (Boston: Gould & Lincoln, 1852; reprint), pp. 8-9.

tions, that could explain the adaptation of organisms to their environment without actually invoking an intelligent or directing agency.

As noted earlier, this trend was reinforced by the emergence of other fully naturalistic origins scenarios in astronomy, cosmology and geology. It was also reinforced by an emerging positivistic tradition in science that increasingly sought to exclude appeals to supernatural or intelligent causes from science *by definition*.[22] Natural theologians such as Robert Chambers, Richard Owen and Asa Gray, writing just prior to Darwin, tended to oblige this convention by locating design in the workings of natural law rather than in the complex structure or functions of natural objects. While this move certainly made the natural-theology tradition more acceptable to shifting methodological canons in science, it also gradually emptied it of any distinctive empirical content, leaving it vulnerable to charges of subjectivity and vacuousness. By locating design more in natural law and less in complex contrivances that could be understood by direct analogy to human creativity, later British natural theologians ultimately made their research program indistinguishable from the positivistic and fully naturalistic science of the Darwinians.[23] As a result, the notion of design, to the extent it maintained any intellectual currency, soon became relegated to a matter of subjective belief. The idea that a mind superintended the workings of nature was still believable, but the assertion that nature and its laws existed on their own was just as believable. Thus by the end of the nineteenth century, natural theologians could no longer point to any specific artifact of nature that required intelligence as a necessary explanation. Intelligent design became undetectable except "through the eyes of faith."

2.3. The Demise of the Cosmological Argument

The demise of the cosmological argument also began with Enlightenment philosophers. Kant, for example, challenged the medieval arguments about the need for a first cause of the universe. To many medievals the principle of causality and the existence of the material universe implied the existence of a necessary first cause—a cause that they equated with God. Kant

[22]For a discussion of this methodological shift, see Neil Gillespie, *Charles Darwin and the Problem of Creation* (Chicago: University of Chicago Press, 1979), pp. 41-66, 82-108.

[23]William A. Dembski, "Demise of British Natural Theology," *Philosophia Christi*, series 2, vol. 1, no. 1 (1999): 17-43.

denied that the universe needed a necessary first cause. He argued that there could be an unbroken line of effects and causes going back infinitely in time, thus eliminating the need for a temporally transcendent or divine first cause. Kant accepted the possibility that the universe itself might be eternal and self-existent.[24]

Kant's skepticism about the cosmological argument, and the *kalam* version of it in particular, was reinforced by the science of his day. Though Newton supported the design argument, one aspect of his physics—the postulation of infinite time and space—helped to undermine the classical *kalam* cosmological argument.[25]

Though Newton's infinite universe[26] had scientific problems even in its

[24]Kant, *Critique*, pp. 511-12.

[25]The *kalam* cosmological argument attempts to argue for the existence of God as a necessary first cause for the origin of a finite universe. The *kalam* argument is not the only version of the cosmological argument, however. Thomas Aquinas argued for God as a necessary first cause of the universe, not in a temporal sense but in an ontological sense (Craig, *Reasonable Faith*, p. 80-83). Gottfried Leibniz championed another version of the cosmological argument in which he postulated God as the only "sufficient reason" for the contingent causal structure of the universe as a whole. These versions of the argument were not predicated on a finite universe. Though they remained in philosophical currency well after the repudiation of the *kalam* argument during the Enlightenment, they had less popular appeal due in part to their philosophical complexity. In any case, the demise of the *kalam* argument had a tremendously negative effect on both popular and scholarly perceptions of the relationship between science and religion. Moreover, its resuscitation as the result of scientific discoveries in the twentieth century has provided considerable epistemic support for a theistic worldview, whatever the status of the Thomistic and Leibnizian versions of the cosmological argument then and now.

[26]According to Newton's theory of universal gravitation, all bodies attract one another with a force proportional to the product of their masses and inversely proportional to the square of the distance between them. His theory implied that *all* bodies of matter in the universe attract one another. Yet this created a puzzle. According to Newton's theory, every star should gravitate toward the center of the universe until the whole universe collapses in on itself. Thus the universe must either be collapsing or expanding (to offset its tendency to collapse). Either way, it could not be static.

To avoid abandoning either his theory of gravity or the notion of a static universe, Newton proposed that "the matter was eavenly diffused through an infinite space" so that "it would never convene into one mass" (Isaac Newton, *The Correspondence of Isaac Newton*, ed. Herbert W. Turnbull et al., 7 vols. [Cambridge: Cambridge University Press, 1959-1977], 3:234). Newton thought that if there were an infinite number of stars scattered evenly throughout an infinite space, then every star would attract every other star with equal force in all directions simultaneously. Thus the stars would remain forever suspended in a tension of balanced gravitational attraction (see Stephen Hawking, *A*

own day, naturalistically minded physicists following Newton found his infinite-and-static universe paradigm philosophically agreeable.[27] Some philosophical naturalists rallied to support the infinite-static model proposed by Newton specifically because it eliminated the need to explain the beginning of time and space. By the end of the nineteenth century this view had become deeply entrenched in the scientific community and provided a powerful reason for rejecting the *kalam* cosmological argument, which depended upon the premise of a finite universe.

2.4. Consequences of the Demise of Theistic Arguments

The demise of these two theistic arguments and the emergence of a fully materialistic account of the origin of the natural world—from the infinite past to the dawn of human life on earth—had a profound effect on the perception of the relationship between science and theistic belief.

Philosophical materialists regarded the emergence a comprehensive materialistic account of natural history as epistemic support for their worldview. Consequently, they perceived science and theism as standing in opposition. If theism asserts the reality of a purposive creation, and if science could account for the origin of living organisms, for example, by reference to wholly undirected material processes, then one of these two views must be incorrect. For this reason the demise of the design and cosmological arguments during the late nineteenth and early twentieth centuries contributed to the rise of the "conflict" model of the relationship between science and religion.

The Darwinian denial of actual design figured centrally in this intellectual shift. Most historians of science now regard as extremely simplistic the attempts by nineteenth century historians such as William Draper and Andrew Dickson White to cast the whole history of science as a battle between science and Christianity.[28] Yet many twentieth-century scientists

Brief History of Time: From the Big Bang to Black Holes [New York: Bantam, 1988], p. 5). Newton also found the infinite universe appealing for theological reasons. Newton thought of space and time as a "Divine Sensorium," a medium in which God perceived his creation. Since God was infinite, space and time had to be as well.

[27]George Smoot and Keay Davidson, *Wrinkles in Time* (New York: William Morrow, 1993), p. 27.

[28]John William Draper, *History of the Conflict Between Religion and Science* (New York: D. Appleton, 1875); and Andrew Dickson White, *A History of the Warfare of Science with Theology in Christendom*, abridged ed. (1896; reprint, New York: Dover, 1960).

and philosophers have held to the conflict model on other grounds. Many conflict advocates cite neo-Darwinism (with its fully naturalistic selection/mutation mechanism for the creation of new biological structure) and other similarly materialistic accounts of origins as the principal and irreconcilable locus of this conflict. Francisco Ayala, Daniel Dennet, William Provine, Douglas Futuyma, Richard Dawkins and the late G. G. Simpson, for example, all agree that neo-Darwinism (taken as a realistic portrayal of the history of life) denies, contra biblical theism, any discernible evidence of divine purpose, guidance, direction or design.[29] Neo-Darwinism teaches, as Simpson once put it, "that man is the result of a purposeless and natural process that did not have him in mind."[30]

Of course, even granting the truth of neo-Darwinism, many evolutionary biologists admit that science cannot categorically exclude the possibility that some kind of deity still might exist. Nor can they deny the possibility of a divine designer who so masks his creative activity in apparently natural processes as to escape scientific detection. Yet for most scientific materialists such an undetectable entity hardly seems worthy of consideration. While the existence of an undetectable designer has remained a logical possibility, the vast majority of Darwinian biologists have rejected this idea as an unnecessary and unparsimonious explanation for the appearance of design in nature. At the very least Darwinism makes "theological explanations" of life "superfluous," as Douglas Futuyma argues.[31] If, however, theism insists that God's qualities "have been clearly seen . . . from what has been made" (Rom 1:20) as the apostle Paul averred, then conflict most certainly exists since, as noted, Darwinism explicitly denies anything more than the appearance of design in nature.

Advocates of independence (or compartmentalism) and complementarity developed their models to defend theistic belief against the aggressive philosophical materialism of many conflict theorists. Even so, advocates of

[29]Ayala, "Darwin's Revolution," pp. 4-5; Daniel C. Dennett, *Darwin's Dangerous Idea: Evolution and the Meanings of Life* (New York: Simon & Schuster, 1995); William Provine, "Evolution and the Foundation of Ethics," *MBL Science* 3, no. 1 (1988): 25-29; Douglas Futuyma, *Evolutionary Biology* (Sunderland, Mass.: Sinauer, 1986); Richard Dawkins, *The Blind Watchmaker* (London: Longman, 1986); George Gaylord Simpson, *The Meaning of Evolution* (Cambridge, Mass.: Harvard University Press, 1967).

[30]Simpson, *Meaning*, pp. 344-45.

[31]Futuyma, *Evolutionary Biology*, p. 3.

these models have generally conceded the failure of science-based theistic arguments. Instead, advocates of independence and complementarity (or "partnership" in Van Till's lexicon) have insisted upon the strict metaphysical and religious neutrality of even the most apparently materialistic origins theories.[32] They have argued that such origins theories do not necessarily contradict theological accounts of creation since God may have used Darwinian or other similarly materialistic processes to create the world. On this view, statements about the purposelessness of evolution do not represent scientific statements per se but "Evolutionism"—an "extrascientific" or "pseudoscientific" apologetic for philosophical materialism. Even so, advocates of independence and complementarity generally have agreed with staunch Darwinists on one point. Both deny that evidence of intelligent design (as opposed to merely apparent design) is scientifically detectable in the living world.

Clearly, the very existence of the independence and complementarity perspectives shows that the demise of the theistic arguments did not eliminate theistic belief, even among scientists. It did, however, radically change the terms of engagement between science and religion. Unlike the early modern scientists such as Kepler, Boyle and Newton, who saw evidence of design in nature as support for their belief in a personal and transcendent God, much of the scientific establishment during the twentieth century would deny that such evidence exists. Thus, since the demise of theistic arguments in the late nineteenth century, scientists have either asserted that science contradicts Christian or theistic belief or they have denied that science has any religious or metaphysical implications whatsoever. Either way, scientists and philosophers have for the most part denied that the testimony of nature lends any support to a theistic worldview.

Part 3: The Return of the God Hypothesis

During the twentieth century a quiet but remarkable shift has occurred in science. Evidence from cosmology, physics and biology now tells a very different story than did the science of the late nineteenth century. Evidence

[32]MacKay, *The Clockwork Image,* pp. 51-55; Howard Van Till, *The Fourth Day* (Grand Rapids, Mich.: Eerdmans, 1986), pp. 208-15; Howard Van Till, Davis Young and Clarence Menninga, *Science Held Hostage* (Downers Grove, Ill.: InterVarsity Press, 1988) pp. 39-43, 127-68.

from cosmology now supports a finite universe, not an infinite one, while evidence from physics and biology has reopened the question of design.

3.1. The Big Bang and General Relativity

In 1915-1916 Albert Einstein shocked the scientific world with his theory of general relativity.[33] Though Einstein's theory challenged Newton's theory of gravity in many important respects, it also implied (as did Newton's) that the universe could not be static but instead was simultaneously expanding and decelerating. According to relativity theory, massive bodies alter the curvature of space so as to draw nearby objects to them. Einstein's conception of gravity implied that all material bodies would congeal unless the effects of gravitation were continually counteracted by the expansion of space itself.[34] Einstein's theory implied an expanding, not a static, universe.

Einstein disliked this idea in part for philosophical reasons. An actively expanding universe implied a beginning to the expansion and thus to the universe.[35] Relativity theory suggested a universe of finite duration racing outward from an initial beginning in the distant past. For Einstein, however, a definite beginning to the universe seemed so counterintuitive that he introduced an arbitrary factor in his theory to eliminate the implication. He postulated a repulsive force, expressed by his "cosmological constant,"[36]

[33]Albert Einstein, "Die Feldgleichungen der Gravitation," *Sitzungsberichte der Koniglich Preussischen Akademie der Wissenschaften,* November 25, 1915, pp. 844-47 (the following reference includes this reference); Einstein, "Die Grundlage der allgemeinen Relativitatstheorie," *Annalen der Physik* 49 (1916): 769-822; the English translation is in H. A. Lorentz et al., *The Principle of Relativity,* with notes by A. Sommerfield and trans. W. Perrett and G. B. Jeffrey (London: Methuen, 1923), pp. 109-64; Eric Chaisson and Steve McMillan, *Astronomy Today* (Englewood Cliffs, N.J.: Prentice-Hall, 1993), p. 604-5.

[34]Arthur S. Eddington, "On the Instability of Einstein's Spherical World," *Monthly Notices of the Royal Astronomical Society* 90 (1930): 668-78.

[35]As the Russian physicist Alexander Friedmann showed in 1922, general relativity implied that, in the words of Stephen Hawking, "at some time in the past (between ten- and twenty-thousand-million years ago) the distance between neighboring galaxies must have been zero" (Hawking, *Brief History,* p. 46; see also Alexander Friedmann, "Uber die Krummung des Raumes," *Zeitschrift Fur Physik* 10 [1922]: 377-86).

[36]Recent measurements showing that the universe may be accelerating in its expansion have resuscitated discussions of the cosmological constant. These measurements seem to require some kind of repulsive force in opposition to gravitation in order to explain the acceleration. These data do not provide any new support for a static or temporarily infinite universe, however. Quite the reverse, they suggest instead a repulsive force now strong enough to accelerate the expansion and to prevent any subsequent con-

of precisely the magnitude necessary to counteract the expansion that his theory implied.[37] By thus seeking to preserve a static universe Einstein, like Newton, inadvertently concealed an important cosmological reality implicit in his theory of gravitation.

Yet the heavens would soon talk back. In the 1920s and 1930s astronomer Edwin Hubble made a series of observations that shocked even Einstein. While working at the Mt. Wilson Observatory in Southern California, Hubble discovered that our Milky Way galaxy is but one of many galaxies spread throughout the universe. More importantly, he discovered that the galaxies beyond the Milky Way are rapidly receding from ours. Hubble noticed that the light from these distant galaxies was shifted toward the red end of the electromagnetic spectrum. This "red shift" suggested recessional movement, for the same reason—the so-called Doppler effect—that a train whistle drops in pitch as a train moves away from a stationary observer. Hubble also discovered that the rate at which these other galaxies retreat from ours is directly related to their distance from us—just as if the universe were undergoing a spherical expansion in all directions from a singular explosive beginning—from a "big bang."[38]

During the remainder of the twentieth century, physicists and cosmologists formulated many alternatives to the new big bang cosmology, most of which restored the idea of an infinite universe. Some of these cosmological models were formulated for explicitly philosophical reasons. For example, in the late 1940s Fred Hoyle, Thomas Gold and Hermann Bondi proposed the "steady state" model specifically to explain galactic recession without invoking the objectionable notion of a beginning. According to their theory, as the universe expands, new matter is generated spontaneously in the space between expanding galaxies. On this

traction from occurring. Indeed, if these results hold up, they will provide additional disconfirmation of another infinite universe cosmology, the oscillating universe model (see below). See P. J. E. Peebles, "Evolution of the Cosmological Constant," *Nature* 398 (1999): 25-26; John Noble Wilford, "Cosmologists Ponder 'Missing Energy' of Universe," *New York Times*, May 5, 1998, F1.

[37]Albert Einstein, "Kosmologische Betrachtungen zur allgemeinen Relativitatstheorie," *Sitzungsberichte der Koniglich Preussischen Akademie der Wissenschaften*, Febuary 8, 1917, pp. 142-52.

[38]Edwin Hubble, "A Relation Between Distance and Radial Velocity Among Extra-Galactic Nebulae," *Proceedings of the National Academy of Sciences* 15 (1929): 168-73.

view our galaxy is composed of matter that spontaneously popped into existence between other galaxies, which in turn came out of the empty space between other galaxies and so on.[39] Thus the steady state theory denied the need to postulate a singular beginning and reaffirmed a universe without beginning or end.

By the mid-1960s, however, Hoyle's theory had run aground as the result of a discovery made at the Bell Telephone Laboratories in New Jersey. According to the steady state model the density of the universe must always remain constant, hence, the creation of new matter as the universe expands. Yet in 1965 two Bell Lab researchers, Arno Penzias and Robert Wilson, found what physicists believed to be the radiation left over from the universe's initial hot, high-density state. The discovery of this "cosmic background radiation," at roughly 2.7 degrees Kelvin, proved decisive.[40] Physicist George Gamow had predicted its existence as a consequence of the big bang model.[41] Advocates of the steady state theory acknowledged that given their model such radiation should not exist. The steady state theory also implied that galaxies should have radically different ages, but advances in observational astronomy have revealed that galactic ages cluster narrowly in the "middle-age" range. By the 1970s even Bondi, Gold and Hoyle had abandoned their theory.[42]

Following the demise of the steady state model, the "oscillating universe" model arose as an alternative to a finite universe. Advocates of this model envisioned a universe that would expand, gradually decelerate, shrink back under the force of its own gravitation and then by some unknown mechanism reinitiate its expansion on and on ad infinitum. But as physicist Alan Guth showed in 1983, our knowledge of entropy suggests that the energy available to do work would decrease with each successive

[39]Hermann Bondi and Thomas Gold, "The Steady-State Theory of the Expanding Universe," *Monthly Notices of the Royal Astronomical Society* 108, no. 3 (1948): 252-70; Fred Hoyle, "A New Model for the Expanding Universe," *Monthly Notices of the Royal Astronomical Society* 108, no. 5 (1948): 372-82.

[40]Arno Penzias and Robert Wilson, "A Measurement of Excess Antenna Temperature at 4080 Mc/s," *Astrophysical Journal* 142, no. 1 (1965): 419-21.

[41]George Gamow, "Expanding Universe and the Origin of the Elements," *Physical Review* 70, nos. 7 and 8 (1946): 572-73.

[42]Helge Kragh, "The Steady State Theory," in *Cosmology: Historical, Literary, Philosophical, Religious, and Scientific Perspectives*, ed. Norriss S. Hetherington (New York: Garland, 1993) pp. 391-406, especially p. 403.

cycle.[43] Thus presumably the universe would have reached a nullifying equilibrium long ago if it had indeed existed for an infinite amount of time. Further, recent measurements suggest that the universe has only a fraction—roughly one-fifth—of the mass required to create a gravitational contraction in the first place.[44]

Prior to the formulation of the oscillating universe theory, three astrophysicists, Stephen Hawking, George Ellis and Roger Penrose, published a series of papers that explicated the implications of Einstein's theory of general relativity for space and time as well as matter and energy.[45] Previously, physicists like Friedmann had shown that the density of the universe would approach an infinite value as one extrapolated the state of the universe back in time. In a series of papers written between 1966 and 1970, Hawking and his colleagues showed that as one extrapolated back in time the curvature of space also approached infinity. But an infinitely curved space corresponds to a radius (within a sphere for example) of zero and thus to no spatial volume. Further, since in general relativity space and time are inextricably linked, the absence of space implies the absence of time. Moreover, neither matter nor energy can exist in the absence of space. Thus Hawking's result suggested that general relativity implies that the universe sprang into existence a finite time ago from literally nothing, at least nothing physical. In brief, general relativity implies an absolute beginning of time, "before" which neither time and space nor matter and energy would have existed.

The space-time theorem of general relativity was, of course, conditional. It stated that if general relativity obtains for the universe, then space and time themselves must have originated in the same initial explosion that created matter and energy. In a series of experiments beginning just two years after Einstein published his results and continuing on to

[43]Alan Guth and Marc Sher, "The Impossibility of a Bouncing Universe," *Nature* 302 (1983): 505-7.

[44]James Peebles, *Principles of Physical Cosmology* (Princeton, N.J.: Princeton University Press, 1993) pp. 475-83; Peter Coles and George Ellis, "The Case for an Open Universe," *Nature* 370 (1994): 609-13; Kathy Sawyer, "Hubble Finding: Expansion of Universe May Never End," *Seattle Times*, January 14, 1992, p. A5; P. J. E. Peebles, "The Mean Mass Density of the Universe," *Nature* 321 (1986): 27-32; Hugh Ross, *The Creator and the Cosmos* (Colorado Springs, Colo.: NavPress, 1993), p. 58.

[45]Stephen Hawking and Roger Penrose, "The Singularities of Gravitational Collapse and Cosmology," *Proceedings of the Royal Society of London*, series A, 314 (1970): 529-48.

the present, the probable error of general relativity (as estimated quantitatively) has shrunk from 10 to 1 to .05 percent, to a confirmation out to the fifth decimal place. Increasingly accurate tests conducted by NASA have continued to shrink the probable error associated with the theory.[46] Thus general relativity now stands as one of the best-confirmed theories of modern science. Yet its philosophical implications and those of the big bang theory are staggering. Taken jointly, general relativity and the big bang theory provide a scientific description of what Christian theologians have long described in doctrinal terms as *creatio ex nihilo*—creation out of nothing. These theories place a heavy demand on any proposed causal explanation of the universe since the cause of the universe must transcend time, space, matter and energy.

3.2. Anthropic "Fine-Tuning"

While evidences from cosmology now point to a transcendent cause for the origin of the universe, new evidences from physics suggest an intelligent cause for the origin of its fundamental architecture. Since the 1960s physicists have discovered that the existence of life in the universe depends upon a highly improbable balance of physical factors.[47] The constants of physics, the initial conditions of the universe and many other of its contingent features appear delicately balanced to allow for the possibility of life. Even very slight alterations in the values of many independent factors such as the expansion rate of the universe or the precise strength of gravitational or electromagnetic attraction, would render life impossible. Physicists now refer to these factors as "anthropic coincidences" and to the fortunate convergence of all these coincidences as the "fine-tuning of the universe." Many have noted that this fine-tuning strongly suggests design by a preexistent intelligence. As physicist Paul Davies has put it, "The impression of design is overwhelming."[48]

To see why, consider the following illustration. Imagine a cosmic

[46]Hugh Ross, *The Creator and the Cosmos*, pp. 66-67; R. F. C. Vessot et al., "Test of Relativistic Gravitation with a Space-Borne Hydrogen Maser," *Physical Review Letters* 45, no. 26 (1980): 2081-84.

[47]See Karl Giberson, "The Anthropic Priniciple," *Journal of Interdisciplinary Studies* 9 (1997): 63-90; response by Steven Yates, pp. 91-104.

[48]Paul Davies, *The Cosmic Blueprint* (New York: Simon & Schuster, 1988), p. 203.

explorer has just stumbled into the control room for the whole universe. There he discovers an elaborate "universe creating machine," with rows and rows of dials each with many possible settings. As he investigates, he learns that each dial represents some particular parameter that has to be calibrated with a precise value in order to create a universe in which life can survive. One dial represents the possible settings for the strong nuclear force, one for the gravitational constant, one for Planck's constant, one for the ratio of the neutron mass to the proton mass, one for the strength of electromagnetic attraction and so on. As our cosmic explorer examines the dials, he finds that the dials can be easily spun to different settings—that they could have been set otherwise. Moreover, he determines by careful calculation that even slight alterations in any of the dial settings would alter the architecture of the universe such that life would cease to exist. Yet for some reason each dial sits with just the exact value necessary to keep the universe running—like a multiple-dial safe cracked open with every dial found in just the right position. What should one infer about how these dial settings came to be set?

Not surprisingly, many physicists have been asking the same question about the anthropic coincidences. As George Greenstein muses:

> The thought insistently arises that some supernatural agency, or rather Agency, must be involved. Is it possible that suddenly, without intending to, we have stumbled upon scientific proof of the existence of a Supreme Being? Was it God who stepped in and so providentially crafted the cosmos for our benefit?"[49]

For many, the design hypothesis seems the most obvious and intuitively plausible answer.[50] As Fred Hoyle commented, "A commonsense interpretation of the facts suggests that a superintellect has monkeyed with physics, as well as chemistry and biology, and that there are no blind forces worth

[49]George Greenstein, *The Symbiotic Universe: Life and Mind in the Cosmos* (New York: Morrow, 1988), p. 26-27.

[50]Greenstein himself does not favor the design hypothesis. Instead, he favors the so-called participatory universe principle or "PAP." PAP attributes the apparent design of the fine tuning of the physical constants to the universe's (alleged) need to be observed in order to exist. As he says, the universe "brought forth life in order to exist . . . that the very Cosmos does not exist unless observed" (see Greenstein, *Symbiotic Universe,* p. 223).

speaking about in nature."[51] Many physicists now concur. They would argue that—in effect—the dials in the cosmic control room appear finely tuned because someone carefully set them that way.

Yet several other types of interpretations have been proposed: (1) the so-called weak anthropic principle, which denies that the fine-tuning needs explanation; (2) explanations based upon natural law; and (3) explanations based on chance. Each of these approaches suggests that the fine-tuning of the universe represents only "apparent" design.

Of these alternate proposals perhaps the most popular approach, at least initially, was the "weak anthropic principle" (WAP). Nevertheless, the WAP has recently encountered severe criticism from philosophers of physics and cosmology. Advocates of WAP claimed that if the universe were not fine-tuned to allow for life, then humans would not be here to observe it. Thus, they claimed, the fine-tuning requires no explanation. Yet as John Leslie and William Craig argue, the origin of the fine-tuning does require explanation.[52] Though we should not be surprised to find ourselves living in a universe suited for life (by definition), we ought to be surprised to learn that the conditions necessary for life are so vastly improbable. Leslie likens our situation to that of a blindfolded man who has discovered that, against all odds, he has survived a firing squad of one hundred marksmen.[53] Though his continued existence is certainly consistent with all the marksmen having missed, it does not explain why the marksmen actually did miss. In essence, the weak anthropic principle asserts that the statement of a necessary condition of an event eliminates the need for a causal explanation of that event. Yet oxygen is a necessary condition of fire, but saying so does not provide a causal explanation of the San Francisco fire. Similarly, the fine-tuning of the physical constants is a necessary condition for the existence of life, but that does not explain or eliminate the need to explain the origin of the fine-tuning.

While some have denied the need to explain the fine-tuning coincidences, others have sought to formulate various naturalistic explanations

[51]Fred Hoyle, "The Universe: Past and Present Reflections," *Annual Review of Astronomy and Astrophysics* 20 (1982): 16.

[52]William Lane Craig, "Cosmos and Creator," *Origins & Design* 20, no. 2 (Spring 1996): 18-28.

[53]John Leslie, "Anthropic Principle, World Ensemble, Design," *American Philosophical Quarterly* 19, no. 2 (1982): 150.

for them. Of these, appeals to natural law have proven the least plausible for a simple reason. The precise "dial settings" of the different constants of physics represent specific features *of the laws of nature themselves*—just how strong gravitational attraction or electromagnetic attraction will be, for example. These values represent contingent features of the fundamental laws themselves. Therefore, the laws cannot explain these features; they *embody* (or possess) the features that require explanation. As Davies has observed, the laws of physics "seem themselves to be the product of exceedingly ingenious design."[54] Further, natural laws by definition describe phenomena that conform to regular or repetitive patterns. Yet the idiosyncratic values of the physical constants and initial conditions constitute a highly irregular and nonrepetitive ensemble. It seems unlikely, therefore, that any law could explain why all the fundamental constants have exactly the values they do—why, for example, the gravitational constant should have exactly the value 6.67×10^{-11} Newton-meters^2 per kilogram^2 *and* the permittivity constant in Coulomb's law the value 8.85×10^{-12} Coulombs^2 per Newton-meter^2 *and* the electron charge to mass ratio 1.76×10^{11} Coulombs per kilogram *and* Planck's constant 6.63×10^{-34} Joule-seconds and so on.[55] These values specify a highly complex array. As a group they do not seem to exhibit a regular pattern that could in principle be subsumed or explained by natural law.

The chance explanation has proven more popular but has severe liabilities as well. First, the immense improbability of the fine-tuning makes straightforward appeals to chance untenable. Physicists have discovered more than thirty separate physical or cosmological parameters that require precise calibration in order to produce a life-sustaining universe.[56] Michael Denton, in *Nature's Destiny,* has documented many other necessary conditions for specifically human life from chemistry, geology and biology.[57] Moreover, many individual parameters exhibit an extraordinarily high degree of fine-tuning. Thus our cosmic explorer not only is confronted with a large ensemble of separate dial settings but with very large dials containing a vast array of possible settings, only very few of which allow for a life-sustaining universe. In many cases the odds against finding a single correct setting by chance, let alone all the correct settings, turn out to be virtually infinitesimal. For example, the force of gravity itself requires fine-tuning to one part in 10^{40}.[58] In addition, Oxford physicist Roger Penrose has noted that a single parameter, the original "phase-space volume," required such precise fine-tuning that the "Creator's aim must have been [precise] to an accuracy of one part in $10^{10^{123}}$." Penrose goes on to remark that, "one could not possibly even write the number down in full" since "it would be '1' followed by 10^{123} successive '0's!"—more zeros than the number of elementary particles in the entire universe. Such, he concludes, is "the precision needed to set the universe on its course."[59]

To circumvent such vast improbabilities, some have postulated the existence of a quasi-infinite number of parallel universes in order to increase the probabilistic resources (roughly, the amount of time and number of trials) available to produce the fine-tuning. In these "many worlds" or "possible worlds" scenarios—which were originally developed as part of the "Everett interpretation" of quantum physics and Andrei Linde's inflationary big bang cosmology—any event that has a nonzero probability, however small, must happen somewhere in some other parallel universe.[60] So long as life has a nonzero probability of arising, it has to arise in some possible world. Therefore, sooner or later some universe had to acquire life-sustaining characteristics.

On the many worlds hypothesis our existence in the universe only appears vastly improbable, since calculations of the probability of the anthropic coincidences arising by chance only consider the "probabilistic

[54]Paul Davies, *The Superforce: The Search for a Grand Unified Theory of Nature* (New York: Simon & Schuster, 1984), p. 243.

[55]David Halliday, Robert Resnick and Jearl Walker, appendix B in *Fundamentals of Physics,* 5th ed. (New York: John Wiley, 1997), p. A3.

[56]See J. Barrow and F. Tipler, *The Anthropic Cosmological Principle* (Oxford: Oxford University Press, 1986), pp. 295-356, 384-444, 510-56; John Gribbin and Martin Rees, *Cosmic Coincidences* (London: Black Swan, 1991) see especially, pp. 3-29, 241-69; Hugh Ross, "The Big Bang Model Refined by Fire," in *Mere Creation: Science, Faith & Intelligent Design,* ed. William A. Dembski (Downers Grove, Ill.: InterVarsity Press, 1998), pp. 363-84, especially pp. 372-81.

[57]Michael Denton, *Nature's Destiny: How the Laws of Biology Reveal Purpose in the Universe* (New York: Free Press, 1998), pp. 47-262.

[58]Paul Davies, *God and the New Physics* (New York: Simon & Schuster, 1983), p. 188.

[59]Roger Penrose, *The Emperor's New Mind* (New York: Oxford, 1989), p. 344.

[60]Andrei Linde, "The Self-Reproducing Inflationary Universe," *Scientific American* 271 (November 1994): 48-55.

resources" available within our universe and neglect the probabilistic resources available from parallel universes. Thus according to the many worlds hypothesis (MWH), chance can explain the existence of life in the universe after all.

The MWH now stands as the most popular naturalistic explanation for the anthropic fine-tuning and thus warrants detailed comment. Though ingenious, the many worlds hypothesis suffers from an overriding difficulty: we have no evidence for any universes other than our own. Moreover, since possible worlds are by definition causally inaccessible to our own world, there can be no evidence for their existence except that they allegedly render probable otherwise vastly improbable events. Of course, no one can observe God directly either, though for theists, God is not causally disconnected from our world. Even so, recent work by philosophers of science like Richard Swinburne, John Leslie, William Craig, Jay Richards and Robin Collins have established several reasons for preferring the theistic-design hypothesis over naturalistic many-worlds hypotheses.[61]

First, all current cosmological models involving multiple universes require some kind of mechanism for generating universes. Yet such a "universe generator" would itself require precisely configured physical states, thus begging the question of its initial design. As Collins describes the dilemma:

> In all currently worked out proposals for what this universe generator could be—such as the oscillating big bang and the vacuum fluctuation models . . .—the "generator" itself is governed by a complex set of laws that allow it to produce universes. It stands to reason, therefore, that if these laws were slightly different the generator probably would not be able to produce any universes that could sustain life.[62]

Indeed, from experience we know that some machines (or factories) can

[61]See, for example, William Lane Craig, "Barrow and Tipler on the Anthropic Principle v. Divine Design," *British Journal for the Philosophy of Science,* 38 (1988): 389-95; and Jay Wesley Richards, "Many Worlds Hypotheses: A Naturalistic Alternative to Design," *Perspectives on Science and Christian Belief* 49, no. 4 (1997): 218-27. See also Alvin Plantinga, *The Nature of Necessity* (Oxford: Clarendon Press, 1980).

[62]Robin Collins, "The Fine-Tuning Design Argument: A Scientific Argument for the Existence of God," in *Reason for the Hope Within,* ed. Michael Murray (Grand Rapids, Mich.: Eerdmans, 1999), p. 61.

produce other machines. But our experience also suggests that such machine-producing machines themselves require intelligent design.

Second, as Collins argues, all things being equal we should prefer hypotheses "that are natural extrapolations from what we already know"[63] about the causal powers of various kinds of entities. Yet when it comes to explaining the anthropic coincidences, the multiple worlds hypothesis fails this test, whereas the theistic-design hypothesis does not. To illustrate, Collins asks his reader to imagine a paleontologist who posits the existence of an electromagnetic "dinosaur-bone-producing-field," as opposed to actual dinosaurs, as the explanation for the origin of large fossilized bones. While certainly such a field qualifies as a possible explanation for the origin of the fossil bones, we have no experience of such fields, nor of their producing fossilized bones. Yet we have observed animal remains in various phases of decay and preservation in sediments and sedimentary rock. Thus most scientists rightly prefer the actual dinosaur hypothesis over the apparent dinosaur hypothesis (that is, the "dinosaur-bone-producing-field" hypothesis), as an explanation for the origin of fossils. In the same way, Collins argues, we have no experience of anything like a "universe generator" (that is not itself designed) producing either finely tuned systems or infinite and exhaustively random ensembles of possibilities. Yet we do have extensive experience of intelligent agents producing finely tuned machines such as Swiss watches. Thus Collins concludes, the postulation of "a supermind" (God) to explain the fine-tuning of the universe constitutes a natural extrapolation from our experience-based knowledge of the causal powers of intelligent agency, whereas the postulation of multiple universes lacks a similar basis.

Third, as Craig shows, for the many-worlds hypothesis to suffice as an explanation for anthropic fine-tuning, there must exist an exhaustively random distribution of physical parameters and thus an *infinite* number of parallel universes to insure that a life-producing combination of factors will eventually arise. Yet neither of the physical models that allow for a multiple-universe interpretation—Everett's quantum mechanical model or Linde's inflationary cosmology—provides a compelling justification for the existence of such an exhaustively random and infinite number of parallel

[63]Ibid., pp. 60-61.

universes, but instead only for a finite and nonrandom set.[64] The Everett model, for example, only generates an ensemble of material *states*, each of which exists within a parallel universe that has the same set of the physical laws and constants as our own. Since these do not vary "across universes," Everett's model, therefore, does nothing to increase the probabilistic resources available to explain the improbably fine-tuning of laws and constants within our own universe. Though Linde's model does envision a variable ensemble of physical constants in each of his individual "bubble universes," his model fails to generate either an exhaustively random set of such conditions or the infinite number of universes required to render probable the fine-tuning of our universe.

Fourth, Richard Swinburne argues that the theistic-design hypothesis constitutes a simpler and less ad hoc hypothesis than the MWH.[65] He notes that virtually the only evidence for many worlds is the very anthropic fine-tuning the hypothesis was formulated to explain. On the other hand, the theistic-design hypothesis, though also supported by indirect evidences, can explain many separate and independent features of the universe that a many-worlds scenario cannot, including the origin of the universe itself, the mathematical beauty and elegance of physical laws, and personal religious experience. Swinburne argues that the God hypothesis constitutes a simpler as well as a more comprehensive explanation in that it requires the postulation of only one explanatory entity rather than the multiple entities, including a finely tuned universe generator and an infinite number of causally separate universes, required by the MWH.

Clifford Longley of the *London Times* wrote in 1989 that the use of such an unparsimonious explanation to avoid the theistic-design argument seems to betray a kind of metaphysical special pleading and desperation.[66] Few people would accept such a far-fetched explanation in any other domain of life. That some scientists dignify MWH with serious discussion may speak more to an unimpeachable commitment to naturalistic philosophy than to any compelling merit for the idea itself.

As the twentieth century comes to a close, the design argument has

[64]Craig, "Cosmos and Creator," p. 24.
[65]Richard Swinburne, "Argument from the Fine Tuning of Universe," in *Physical Cosmology and Philosophy*, ed. John Leslie (New York: Macmillan, 1990), pp. 154-73.
[66]Clifford Longley, "Focusing on Theism," *London Times*, January 21, 1989, p. A10.

reemerged from its premature retirement at the hands of biologists in the nineteenth century. Physics, astronomy, cosmology and chemistry have each revealed that life depends on a very precise set of design parameters, which, as it happens, have been built into our universe. The fine-tuning evidence has led to a persuasive reformulation of the design argument, though not a formal deductive proof of God's existence. As a result, physicist John Polkinghorne notes that

> we are living in an age where there is a great revival of natural theology taking place. That revival of natural theology is taking place not on the whole among theologians, who have lost their nerve in that area, but among the scientists.[67]

Polkinghorne also notes that this revived natural theology generally has more modest ambitions than the natural theology of the Middle Ages. Nevertheless, his statement suggests that a profound intellectual shift has begun taking place as physics and related disciplines reveal new evidence that appears to support theistic belief.

3.3. Evidence of Intelligent Design in Biology

Despite renewed interest in the design hypothesis among physicists and cosmologists, many biologists have long-remained reluctant to consider such notions. Indeed, since the late-nineteenth century, biologists have mostly rejected the idea that biological organisms manifest evidence of intelligent design. While many acknowledge the *appearance* of design in biological systems, they insist that purely naturalistic mechanisms such as natural selection acting on random variations can give a full account of how this appearance arose.

3.3.1. Molecular Machines

In spite of the misgivings of many, the rumblings about design have begun to spread to biology. In 1998 for example, the leading journal *Cell* featured a special issue on macromolecular machines. Molecular machines are incredibly complex devices that all cells use to process information, build

[67]John Polkinghorne, "So Finely Tuned a Universe of Atoms, Stars, Quanta & God," *Commonweal*, August 16, 1996, p. 16.

proteins and move materials back and forth across their membranes. Bruce Alberts, president of the National Academy of Sciences, notes that molecular machines strongly resemble machines designed by human engineers, although as an orthodox neo-Darwinian he denies any role for actual, as opposed to apparent, design in the origin of these systems.

In recent years, however, a formidable challenge to this view has arisen within biology. In *Darwin's Black Box,* Lehigh University biochemist Michael Behe shows that neo-Darwinists have failed to explain the origin of complex molecular machines in living systems. For example, Behe looks at the ion-powered rotary engines that turn the whiplike flagella of certain bacteria.[68] He shows that the intricate machinery in this molecular motor—including a rotor, a stator, O-rings, bushings and a drive shaft—requires the coordinated interaction of some forty complex protein parts. Yet the absence of any one of these proteins result in the complete loss of motor function. To assert that such an "irreducibly complex" engine emerged gradually in a Darwinian fashion strains credulity. Natural selection selects functionally advantageous systems. Yet motor function only ensues *after* all necessary parts have independently self-assembled—an astronomically improbable event. Thus Behe insists that Darwinian mechanisms cannot account for the origin of molecular motors and other "irreducibly complex systems" that require the coordinated interaction of multiple, independent protein parts.

To emphasize his point Behe conducted a literature search of relevant technical journals.[69] He found a pervasive absence of gradualistic Darwinian explanations for the origin of the systems and motors that he discusses. Behe concludes that neo-Darwinists have neither explained nor, in most cases, even attempted to explain how the appearance of design in "irreducibly complex" systems arose naturalistically. Instead, he notes that we know of only one cause sufficient to produce functionally integrated, irreducibly complex systems—intelligent design. Whenever we encounter irreducibly complex systems and we know how they arose, invariably a designer played a causal role. Thus Behe concludes on strong uniformitarian grounds that the molecular machines and complex systems we observe in cells must

[68]Michael J. Behe, *Darwin's Black Box* (New York: Free Press, 1996), pp. 51-73.
[69]Ibid., pp. 165-86.

have also had an intelligent source. In brief, molecular motors appear designed because they were designed.

3.3.2. The Complex Specificity of Cellular Components

Other developments in biology reinforce Behe's argument. The molecular machines that Behe examines inside the cell are built from smaller components known as proteins. In addition to building motors and other biological structures, proteins perform vital biochemical functions—information processing, metabolic regulation, signal transduction—necessary to maintain cellular life. Biologists, from Darwin's time to the late 1930s, assumed that proteins had simple, regular structures explicable by reference to mathematical laws.

Beginning in the 1950s, however, biologists made a series of discoveries that caused this simplistic view of proteins to change. Molecular biologist Fred Sanger determined the sequence of constituents in the protein molecule insulin. Sanger's work showed that proteins are made of long nonrepetitive sequences of amino acids, rather like an irregular arrangement of colored beads on a string.[70] Later in the 1950s, work by John Kendrew on the structure of the protein myoglobin showed that proteins also exhibit a surprising three-dimensional complexity. Far from the simple structures that biologists had imagined, Kendrew's work revealed an extraordinarily complex and irregular three-dimensional shape—a twisting, turning, tangled chain of amino acids.

During the 1950s scientists quickly realized that proteins possess another remarkable property. In addition to their complexity, proteins also exhibit specificity, both as one-dimensional arrays and as three-dimensional structures. Whereas proteins are built from rather simple chemical building blocks known as amino acids, their function—whether as enzymes, signal transducers or structural components in the cell—depends crucially on the complex but specific sequencing of these building blocks.[71]

[70]Horace Judson, *Eighth Day of Creation* (New York: Simon & Schuster, 1979), pp. 213, 229-35, 255-61, 304, 334-35; Fred Sanger and Hans Tuppy, "The Amino Acid Sequence in the Phenylalanyl Chain of Insulin, 1 and 2," *Biochemical Journal* 49, no. 4 (1951): 463-80; Fred Sanger and E. O. P. Thompson, "The Amino Acid Sequence in the Glycyl Chain of Insulin, 1 and 2," *Biochemical Journal* 53, no. 3 (1953): 353-66, 366-74.
[71]Bruce Alberts et al., *Molecular Biology of the Cell* (New York: Garland, 1983), pp. 91-141.

Molecular biologists like Francis Crick quickly likened this feature of proteins to a linguistic text. Just as the meaning (or function) of an English text depends on the sequential arrangement of letters in a text, so too does the function of a polypeptide (a sequence of amino acids) depend on its specific sequencing. Moreover, in both cases slight alterations in sequencing can quickly result in loss of function.

In the biological case the specific sequencing of amino acids gives rise to specific three-dimensional structures. This structure or shape in turn determines what function, if any, the amino acid chain can perform within the cell. For a functioning protein its three-dimensional shape gives it a hand-in-glove fit with other molecules in the cell, enabling it to catalyze specific chemical reactions or to build specific structures within the cell. Due to this specificity one protein can usually no more substitute for another than one type of tool can substitute for another type. Proteins can perform functions only by virtue of their three-dimensional specificity of fit with other equally specified and complex molecules within the cell. This three-dimensional specificity derives in turn from a one-dimensional specificity of sequencing in the arrangement of the amino acids that form proteins.

3.3.3. The Sequence Specificity of DNA

The complexity and specificity of proteins both as one-dimensional arrays and three-dimensional structures raised an important question. How did such complex but specific structures arise in the cell? This question recurred with particular urgency after Sanger revealed his results in the early 1950s. Clearly, proteins were too complex and functionally specific to arise "by chance." Moreover, given their irregularity it seemed unlikely that a general chemical law or regularity governed their assembly. Instead, as Jacques Monod recalled, molecular biologists began to look for some source of information within the cell that could direct the construction of these highly specific structures. To explain the presence of all that information in the protein "you absolutely needed a code," as Monod would later explain.[72]

In 1953 James Watson and Francis Crick elucidated the structure of the

[72]Jacques Monod, cited in Judson, *Eighth Day*, p. 611.

DNA molecule.[73] Soon thereafter molecular biologists discovered how DNA stores the information necessary to direct protein synthesis. In 1955 Crick first proposed the "sequence hypothesis," suggesting that the specificity of amino acids in proteins derives from the specific arrangement of chemical constituents in the DNA molecule.[74] According to the sequence hypothesis, information on the DNA molecule is stored in the form of specifically arranged chemicals called nucleotide bases along the spine of DNA's helical strands. Chemists represent these four nucleotides with the letters A, T, G and C (for adenine, thymine, guanine and cytosine). By 1961 the sequence hypothesis became part of the so-called central dogma of molecular biology after a series of brilliant experiments confirmed DNA's information-bearing properties.

As it turns out, specific regions of the DNA molecule called *coding regions* have the same property of "sequence specificity" or "specified complexity" that characterizes written codes, linguistic texts and protein molecules. Just as the letters in the alphabet of a written language may perform a communication function depending on their sequencing, so too may the nucleotide bases in DNA produce a functional protein depending on their precise sequential arrangement. The nucleotide bases in DNA function in precisely the same way as symbols in a computer code or alphabetic characters in a book. In each case the arrangement of the characters determines the function of the sequence as a whole. As Dawkins notes, "The machine code of the genes is uncannily computer-like."[75] Or as Bill Gates avers, "DNA is like a computer program, but far, far more advanced than any software we've ever created."[76] In the case of a computer code the specific arrangement of just two symbols (0 and 1) suffices to carry information. In the case of an English text the twenty-six letters of the alphabet do the job. In the case of DNA, the complex but precise sequencing of the four nucleotide bases (A, T, G and C) stores and transmits genetic information—information that finds expression in the construction of specific proteins.

[73]James Watson and Francis Crick, "A Structure for Deoxyribose Nucleic Acid," *Nature* 171 (1953): 737-38.
[74]Judson, *Eighth Day*, pp. 335-36; Alberts et al., *Molecular Biology*, pp. 106-10.
[75]Richard Dawkins, *River Out of Eden* (New York: BasicBooks, 1995), p. 10.
[76]Bill Gates, *The Road Ahead* (Boulder, Colo.: Blue Penguin, 1996), p. 228.

Developments in molecular biology have raised the question of the ultimate origin of the specific sequencing—the information content—in both DNA and proteins. These developments have also created severe difficulties for all strictly naturalistic theories of the origin of the first cellular life. Since the late 1920s naturalistically minded scientists have sought to explain the origin of the very first life as the result of a completely undirected process of "chemical evolution." Chemical evolutionary theorists such as Alexander I. Oparin envisioned life arising by a slow process of transformation starting from simple chemicals on the early earth.[77] Unlike Darwinism, which sought to explain the origin and diversification of new and more complex living forms from simpler preexisting forms, chemical evolutionary theory seeks to explain the origin of the very first cellular life. Yet since the late 1950s naturalistic chemical evolutionary theories have been unable to account for the origin of the specified complexity or information content necessary to build a living cell.[78]

Chance-based models of chemical evolution have failed since the amount of specified information present in even a single protein or gene—a section of DNA for building a single protein—typically exceeds the probabilistic resources of the entire universe.[79] Models based on "pre-biotic natural selection" have failed since they presuppose the existence of a self-

[77]Alexander I. Oparin, *The Origin of Life,* trans. S. Morgulis (New York: Macmillan, 1938), see esp. pp. 64-103, 98-108, 133-35, 148-59, 195-96.

[78]For a good summary and critique of different naturalistic models see especially K. Dose, "The Origin of Life: More Questions Than Answers," *Interdisciplinary Science Review* 13, no. 4 (1988): 348-56; H. P. Yockey, *Information Theory and Molecular Biology* (Cambridge: Cambridge University Press, 1992), pp. 259-93; C. Thaxton, W. Bradley and R. Olsen, *The Mystery of Life's Origin* (Dallas: Lewis & Stanley, 1992); R. Shapiro, *Origins* (London: Heinemann, 1986); Stephen C. Meyer, "The Explanatory Power of Design: DNA and the Origin of Information," in *Mere Creation: Science, Faith & Intelligent Design,* ed. William A. Dembski (Downers Grove, Ill.: InterVarsity Press, 1998), pp. 203-17.

[79]William A. Dembski, *The Design Inference* (Cambridge University Press, 1998), pp. 203-17; Meyer, "Explanatory Power," pp. 124-26; Yockey, *Information Theory and Molecular Biology,* pp. 246-58; H. J. Morowitz, *Energy Flow in Biology* (New York: Academic Press, 1968), pp. 5-12; A. G. Cairns-Smith, *The Life Puzzle* (Edinburgh: Oliver & Boyd, 1971), pp. 92-96; Shapiro, *Origins,* pp. 117-31; J. Bowie and R. Sauer, "Identifying Determinants of Folding and Activity for a Protein of Unknown Structure," *Proceedings of the National Academy of Sciences USA* 86 (1989): 2152-56.

replicating system.[80] Yet this in turn presupposes the presence of information-rich DNA and protein molecules—the very entities that require explanation in the first place. Finally, self-organizational models have failed since the information content of DNA defies explanation by reference to the physical and chemical properties of its constituent parts.[81] Just as the chemistry of ink does not explain the origin of the specific sequencing of letters in a newspaper headline, so too the properties of the chemical constituents of DNA text—the four nucleotide bases—do not explain the specific sequencing of the genetic text. As Michael Polanyi put it, "As the arrangement of a printed page is extraneous to the chemistry of the printed page, so is the base sequence in a DNA molecule extraneous to the chemical forces at work in the DNA molecule."[82]

3.4. DNA by Design

The presence of specified information in DNA suggests a source extrinsic to physics and chemistry. When one seeks the source of the information in this morning's newspaper or in an ancient inscription, one comes ultimately to a writer or scribe. When a computer user traces the information on a screen back to its source, a writer, software engineer or programmer invariably comes to mind. If, as Gates states, DNA is similar to but more complex than a software program (in its information content), it makes sense to infer that it too had an intelligent source.

Though DNA is similar to a computer program, the case for its design does not depend on mere resemblance. Classical design arguments in biol-

[80]Meyer, "Explanatory Power," pp. 126-28; Mora, "The Folly of Probability," pp. 311-12; L. V. Bertalanffy, *Robots, Men and Minds* (New York: George Braziller, 1967), p. 82; T. Dobzhansky, "Discussion of G. Schramm's Paper," in *The Origins of Prebiological Systems and of Their Molecular Matrices,* ed. S. W. Fox (New York: Academic Press, 1965), p. 310; H. H. Pattee, "The Problem of Biological Hierarchy," in *Towards a Theoretical Biology,* ed. C. H. Waddington (Edinburgh: Edinburgh University Press, 1970), 3:123.

[81]Meyer, "Explanatory Power," pp. 128-34; Thaxton, Bradley and Olson, *The Mystery of Life's Origin,* pp. 113-66; H. P. Yockey, "Self-Organization Origin of Life Scenarios and Information Theory," *Journal of Theoretical Biology* 91 (1981): 13-31; Michael Polanyi, "Life's Irreducible Structure," *Science* 160 (1968): 1309; B. Kuppers, "On the Prior Probability of the Existence of Life," in *The Probabilistic Revolution,* ed. Kruger et al. (Cambridge, Mass.: MIT Press, 1987), p. 364; R. A. Kok, J. A. Taylor and Walter L. Bradley, "A Statistical Examination of Self-Ordering of Amino Acids in Proteins," *Origins of Life and Evolution of the Biosphere* 18 (1988): 135-42.

[82]Polanyi, "Life's Irreducible Structure," p. 1309.

ogy typically sought to draw *analogies* between whole organisms and machines based on certain similar features that each held in common. These arguments sought to reason from similar effects back to similar causes. The status of such design arguments thus turned on the degree of similarity that actually obtained between the effects in question. Yet since even advocates of these classical arguments admitted dissimilarities as well as similarities, the status of these arguments always appeared uncertain. Advocates would argue that the similarities between organisms and machines outweighed dissimilarities; critics would claim the opposite.

The design argument from the information in DNA does not depend on such analogical reasoning since it does not depend on claims of similarity.[83] The coding regions of DNA have the very same property of "sequence specificity" or "information content" that computer codes and linguistic texts have. Though DNA does not possess all the properties of natural language or "semantic information"—that is, information that is subjectively meaningful to human agents—it does have precisely those properties that jointly imply a prior intelligence.

William Dembski has shown in his recent book *The Design Inference* that systems or sequences that have the joint properties of "high complexity and specification" invariably result from intelligent causes, not chance or physical-chemical necessity. Complex sequences are those that exhibit an irregular and improbable arrangement that defies expression by a simple rule or algorithm. A specification, on the other hand, is a match or correspondence between a physical system or sequence and a set of independent functional requirements or constraints. As it turns out, the base sequences in the coding regions of DNA are both highly complex and specified. The sequences of bases in DNA are highly irregular, nonrepetitive and improbable—and, therefore, also complex. Moreover, the coding regions of DNA exhibit sequential arrangements of bases that are necessary (within certain tolerances) to produce functional proteins—that is, they are highly specified with respect to the independent requirements of protein function and protein synthesis.[84] Thus, as nearly all molecular biologists now recognize, the coding regions of DNA possess a

[83]Elliot Sober, *Philosophy of Biology* (San Francisco: Westview, 1993), pp. 26-47.
[83]Thaxton and Bradley, "Information," pp. 173-210; Thaxton, *Mystery*, pp. 127-66.
[84]Yockey, *Information Theory*, pp. 242-93.

high information content—where "information content" in a biological context means precisely "complexity and specificity."[85]

Thus the design argument from information content in DNA does not depend on analogical reasoning, since it does not depend on assessments of degree of similarity. The argument does not depend on the *similarity* of DNA to a computer program or human language but on the presence of an identical feature ("information content" defined as "complexity and specification") in both DNA and all other designed systems, languages or artifacts. While a computer program may be similar to DNA in many respects and dissimilar in others, it exhibits a precise identity to DNA in its ability to store information content.

As such, this argument does not represent an argument from analogy, of the sort that Hume criticized, but an "inference to the best explanation." Such arguments turn not on assessments of the degree of similarity between effects but instead on an assessment of the adequacy of competing possible causes for the same effect. Since we know intelligent agents can (and do) produce functionally specified sequences of symbols or arrangements of matter (information content), intelligent agency qualifies as a sufficient causal explanation for the origin of this effect. In addition, since naturalistic scenarios have proven universally inadequate for explaining the origin of information content, mind or creative intelligence now stands as the best and only entity with the causal power to produce this feature of living systems.

[85]The term *information content* is used variously to denote both specified complexity and unspecified complexity. Yet a sequence of symbols that is merely complex but not specified (such as "wnsgdtej38ejdfmfcksdncnmd") would not necessarily indicate the activity of a designing intelligence. Thus it may be argued that design arguments based on the presence of information commit a fallacy of equivocation by inferring design from a type of "information" (i.e., unspecified information) that could result from random natural processes. Ambiguities in the definition of information and information content do leave open this possibility. One can foreclose this possibility, however, by defining information content as equivalent to the joint properties of complexity and specification. Though the term is not used this way universally in information theory, it has been used this way by biologists from the beginning of the molecular biological revolution. As Sarkar points out, since the mid-1950s Francis Crick and others have equated "information" not only with complexity but also with what they called "specificity"—where they understood specificity to mean "necessary to function." See Sahotra Sarkar, ed., "Biological Information: A Skeptical Look at Some Central Dogmas of Molecular Biology," in *The Philosophy and History of Molecular Biology: New Perspectives* (Dordrecht: Kluwer, 1996), p. 191.

Indeed, experience teaches that whenever we encounter specified complexity or high information content in an artifact or entity whose causal story is known, invariably creative intelligence has played a causal role in the origin of that entity. In other words, since experience suggests that intelligent design is an empirically *necessary* cause of an information-rich system (the only cause known to be capable of producing the effect), one can detect (or, logically, retrodict) the past action of an intelligent cause from the presence of such an effect, even if the cause itself cannot be directly observed.[86] The specified pattern of red and yellow flowers spelling "Welcome to Victoria" in the gardens of Victoria harbor in Canada lead visitors to infer the activity of intelligent agents (gardeners), even if they did not see the flowers planted and arranged. The arrangement of symbols on the Rosetta Stone led archaeologists to infer the work of scribes, though archaeologists could make no direct observations of them working. Similarly, the specifically arranged nucleotide sequences—the information content—in DNA suggests the past action of an intelligent mind, even though such mental agency cannot be directly observed. Intelligent agents have unique causal powers that nature does not. Since DNA displays precisely an effect—information content—that in our experience only intelligent agents can produce, intelligent design—not apparent design—stands as the best explanation for the information content (or specified complexity) in DNA.

Part 4: Reconceptualizing Epistemic Support

Despite the rather dramatic developments in cosmology and biology during the twentieth century, many scientists and theologians remain reluctant to revise their understanding of the relationship between science and theistic belief. True, there are perhaps fewer scientists today than in the late nineteenth century who would assert that science and religion stand in overt conflict. Yet many scientists and theologians still deny that science can provide evidential or epistemic support for Judeo-Christian or theistic belief. Instead, they express skepticism about what they see as a return to the failed "natural theology" of the nineteenth century or to rationalistic attempts to prove the existence of God. They point out, perhaps rightly, that

[86]Stephen C. Meyer, "Of Clues and Causes: A Methodological Interpretation of Origin of Life Studies," (Ph.D. dissertation, University of Cambridge, 1990), pp. 77-140; Meyer, "Explanatory Power," pp. 82-97.

neither the evidence for a cosmological singularity nor the evidence of design in physics and biology can prove God's existence. Thus many theologians and scientists continue to affirm the strict neutrality of science and deny that science does (or can) support theistic belief.

Consider the view of Ernan McMullin, a prominent philosopher of science and a theologian at the University of Notre Dame. McMullin explicitly denies that the big bang theory provides any evidential support for Christian theism, though he admits that if one assumed the Christian doctrine of creation, one might expect to find evidence for a beginning to time. As he explains:

> What one could say . . . is that if the universe began in time through the act of a Creator, from our vantage point it would look something like the Big Bang that cosmologists are talking about. What one cannot say is . . . that the Big Bang model "supports" the Christian doctrine of Creation.[87]

4.1. Deduction and The Logic of Entailment

Many philosophers, scientists and theologians assume that scientific evidence (represented here as *A*) can provide epistemological support for, or grounds for, believing a theological proposition *B* only if the theological proposition *B* follows from evidence *A* with deductive certainty. They assume that to succeed in providing epistemic support for God's existence or other propositional commitments of theism, arguments must necessarily take a deductive logical form such as:

If *A*, then *B*
A
———
Therefore *B*

Of course, many arguments for God's existence have been framed in precisely such a deductive manner. Recall, for example, the classic statement of the *kalam* cosmological argument for God's existence.[88]

[87]Ernan McMullin, "How Should Cosmology Relate to Theology?" in *The Sciences and Theology in the Twentieth Century*, ed. Arthur R. Peacocke (Notre Dame, Ind.: University of Notre Dame Press, 1981), p. 39.
[88]Craig, *Reasonable Faith*, p. 92.

Whatever begins to exist has a cause.
The universe began to exist.

Therefore, the universe has a cause.

Such deductive arguments utilize the standard *modus ponens* logical form. Thus they are logically valid. If the premises of such arguments are true and can be known to be true with certainty, then the conclusion follows with certainty as well. In such arguments, logicians say the premises "entail" the conclusions. Of course, finding premises that can be known to be true with certainty can be very difficult, especially in an empirically based inquiry such as natural science. Many deductive arguments for God's existence failed for exactly this reason. Nevertheless, deductive entailment from true premises does constitute a perfectly legitimate, if infrequently attained, form of epistemic support. If *A* logically compels *B*, then it is irrational to deny *B* if one affirms *A*. In such cases *A* clearly provides support for *B*.[89] Even so, deductive entailment involves a far stronger notion of support than empirical science requires. Scientists rarely prove their theories deductively from empirical evidence. Indeed, no field of inquiry short of mathematics could progress if it limited itself to the logic of entailment. Rather, most fields of inquiry employ alternate forms of inference known variously as the method of hypothesis, abduction, hypothetico-deductive method or inference to the best explanation.

4.2. Abduction and the Logic of Confirmation of Hypothesis

During the nineteenth century a logician named C. S. Peirce described the modes of inference that we use to derive conclusions from data.[90] Peirce noted that in addition to deductive arguments, we often employ a mode of logic he called "abduction" or "the method of hypothesis." To see the difference between these two types of inference, consider the following argument schemata.[91]

[89]Dembski and Meyer, "Fruitful Interchange or Polite Chitchat?" 418-22.
[90]C. S. Peirce, *Collected Papers,* ed. Charles Hartshorne and Paul Weiss (Cambridge: Harvard University Press, 1931), 2:375.
[91]Meyer, "Of Clues and Causes," p. 25.

Deductive schema
Data: A is given and plainly true.
Logic: *But if A is true, then B is a matter of course.*
Conclusion: Hence, B must be true as well.

Abductive schema
Data: The surprising fact B is observed.
Logic: *But if A were true, then B would be a matter of course.*
Conclusion: Hence, there is reason to suspect that A is true.

In the logic of the deductive schema, if the premises are true, the conclusion follows with certainty. The logic of the abductive schema, however, does not produce certainty but instead plausibility or possibility. Unlike deduction, in which the minor premise affirms the antecedent variable A, abductive logic affirms the consequent variable B. In deductive logic, affirming the consequent variable (with certainty) constitutes a fallacy—a fallacy that derives from the failure to acknowledge that more than one antecedent might explain or produce the same consequent. To see why, consider the following argument:

If it rains the streets will get wet.
The streets are wet.

Therefore, it rained.

Or symbolically:

If R, then W
W

Therefore R

Obviously this argument has a problem as it stands. It does not follow that because the streets are wet, it necessarily rained. The streets may have gotten wet in some other way. A fire hydrant may have burst, a snow bank may have melted or a street sweeper may have doused the street before beginning a cleaning operation. Nevertheless, that the streets are wet *might* indicate that it has rained. Thus amending the argument as fol-

lows does not commit the fallacy:

If it rains, then we would expect the streets to get wet.
The streets are wet.

Therefore *perhaps* it rained.

Or symbolically:

If R, then W
W

Perhaps R

Even if one may not affirm the consequent with certainty, one may affirm it as a possibility. And this is precisely what abductive logic does. It provides a reason for considering that a hypothesis may be true. Indeed, it gives a reason for believing a hypothesis, even if one cannot affirm the hypothesis (or conclusion) with certainty.

The natural and historical sciences employ such logic routinely. In the natural sciences, if we have reason to expect that some state of affairs will ensue given some hypothesis, and we find that such a state of affairs has ensued, then we say that our hypothesis has been confirmed. This method of "confirmation of hypothesis" functions to provide evidential support for many scientific hypotheses. Given Copernicus' heliocentric theory of the solar system, astronomers in the seventeenth century had reason to expect that the planet Venus should exhibit phases. Galileo's discovery that Venus does exhibit phases, therefore, supported (though it did not prove) the heliocentric view. The discovery did not prove the heliocentric theory since other theories might—and in fact could—explain the same fact.[92]

Peirce acknowledged that abductive inferences on their own may constitute a rather weak form of epistemic support. Yet as a practical matter Peirce acknowledged that abduction often yields conclusions that are difficult to doubt even if they lack the airtight certainty that accompanies the logic of deduction. For instance, Peirce argued that skepticism about the existence of Napoleon Bonaparte was unjustified even though Napoleon's existence could

[92]Owen Gingerich, "The Galileo Affair," *Scientific American* 247, no. 2 (1982): 133-43.

be known only by abduction. As Peirce put it, "Numberless documents refer to a conqueror called Napoleon Bonaparte. Though we have not seen the man, yet we cannot explain what we have seen, namely, all these documents and monuments, without supposing that he really existed."[93] Thus Peirce suggested that by considering the explanatory power of a hypothesis, the logic of abduction might underwrite more robust relations of epistemic support.

4.3. The Logic of Comparative Explanatory Power: Inference to the Best Explanation

Since Peirce's time, philosophers of science have refined his abductive logic to show how abductive inferences (or confirmation of hypothesis) can provide a stronger form of epistemic support. The abductive framework of logic employed by natural scientists and others often provides a weak form of epistemic support, since it leaves open many possible explanations for the same evidence. Philosophers of science have recognized that scientists often have to evaluate the explanatory power of competing possible hypotheses. This method, alternatively called "the method of multiple competing hypotheses"[94] or "inference to the best explanation,"[95] often reduces, at least for practical purposes, the uncertainty or "underdetermination" associated with abductive inference. In this method of reasoning the explanatory or predictive virtues of a potential hypothesis determine which among a competing set of possible explanations constitutes the best.[96] Scientists infer that hypothesis among a competing group of hypotheses that would, if true, provide the best explanation of some set of relevant data. True, both an earthquake and a bomb could explain the destruction of the building, but only the bomb can explain the presence of charring and

[93]Peirce, *Collected Papers*, p. 375.

[94]T. C. Chamberlin, "The Method of Multiple Working Hypotheses," *Science* 148 (1890; reprint, 1965): 754-59.

[95]Meyer, "Of Clues and Causes," pp. 90-97; Peter Lipton, *Inference to the Best Explanation* (London: Routledge, 1991), pp. 1-5, 6-8, 56-74; Sober, *Philosophy of Biology*, pp. 1-8, 27-46, 56-74, 92-96.

[96]Recent work in the philosophy of science suggests that predictive success constitutes a special case of explanatory power in which a theory's ability to predict an event stands as evidence of its ability to explain it. See Lipton, *Inference;* Michael Scriven, "Explanation and Prediction in Evolutionary Theory," *Science* 130 (1959): 477-82; and Stephen Brush, "Prediction and Theory Evaluation: the Case of Light Bending," *Science* 246 (December 1989): 1124-27.

shrapnel at the scene of the rubble.

This example suggests that considerations of causal adequacy often determine which among a set of possible explanations will constitute the best. Indeed, recent work on the method of "inference to the best explanation" suggests that determining which among a set of competing possible explanations constitutes the best depends on assessments of the causal powers of competing explanatory entities.[97] Entities or events that have the capability to produce the evidence in question constitute better explanations of that evidence than those that do not. It follows that the process of determining the best explanation often involves generating a list of possible hypotheses, comparison of their known (or theoretically plausible) causal powers with respect to the relevant data, and the progressive elimination of potential but inadequate explanations. Of course, in some situations more than one hypothesis may serve as an adequate explanation for a given fact. Typically in such situations scientists expand their evaluation to include an ensemble of relevant data to discriminate between the explanatory power of various abductive hypotheses.[98]

Inference to the best explanation (IBE) as a method of reasoning has a number of advantages over either deduction or simple abduction. First, IBE can provide a strong form of epistemic support without having to achieve the often unrealistic standard of deductive certainty. If the logic of confirmation provides a weak form of epistemic support by suggesting a reason for believing that a hypothesis might be true, then the logic of comparative explanatory power—the method of IBE—can provide a stronger form of support by giving a reason for preferring a possibly true hypothesis over all competitors. As Peirce noted in his discussion of the evidence for Napoleon, considerations of explanatory power may establish an inference beyond reasonable doubt, even if the abductive form of argument cannot categorically exclude other logical possibilities.

Second, in discussions of reason (or science) and faith, IBE provides a way of avoiding fideism—belief without justification, or faith in faith

[97]Lipton, *Inference,* pp. 72-88; Stephen Meyer, "The Methodological Equivalence of Design & Descent: Can There be a Scientific Theory of Creation?" in *The Creation Hypothesis,* ed. J. P. Moreland (Downers Grove, Ill.: InterVarsity Press, 1994), pp. 67-112, 300-312, especially pp. 88-94.

[98]Meyer, "Of Clues and Causes," pp. 99-108, esp. p. 102.

alone—on the one hand or a return to strict rationalism on the other. If as both rationalists and fideists assume, deductive proofs provide the only way to support a Christian worldview, then if such proofs fail, fideism or skepticism stand as the only alternatives. If, however, scientific or other evidences suggest theism as a better explanation than competing metaphysical systems or worldviews, then one can affirm an evidential basis for theistic belief without embracing the failed rationalism of the past.

Part 5: Theism as an Inference to the Best Explanation

With confirmation of hypothesis and explanatory power rather than deductive entailment constituting epistemic support, we can now see how recent developments in modern science provide support for theism. Curiously, in the very passage in which he denies that the big bang model supports the Christian doctrine of creation, McMullin suggests this very possibility: "If the universe began in time through the act of a Creator . . . it would look something like the Big Bang that cosmologists are talking about."[99] But does this not simply mean that if we assume the Christian doctrine of creation (or theism) as a kind of metaphysical hypothesis, then the big bang is the kind of cosmological theory we have reason to expect? As Arno Penzias has said, "the best data we have (concerning the big bang) are exactly what I would have predicted had I nothing to go on but the first five books of Moses, the Psalms and the Bible as a whole."[100] But again, doesn't this statement and McMullin's imply that the big bang theory provides a kind of confirmation of the Judeo-Christian understanding of creation and with it a theistic worldview? The previous discussion of confirmation would certainly seem to suggest as much. Explicating the above statements as an abductive syllogism helps to explain why.

> If theism and the Judeo-Christian view of creation are true, then we have reason to expect evidence of a finite universe.
> *We have evidence of a finite universe.*
> Therefore, theism and the Judeo-Christian view of creation may be true.

[99]McMullin, "Cosmology," p. 39.

[100]Arno Penzias, quoted in Malcolm W. Browne, "Clues to Universe Origin Expected," *New York Times,* March 12, 1978, p. 54.

This syllogism suggests that the big bang theory functions to confirm the metaphysical hypothesis of theism in much the same way that empirical observations confirm scientific theories. It follows that the big bang does provide epistemic support for theism, at least in this limited way.

Yet the big bang theory may provide an even stronger form of epistemic support. Metaphysics offers a multitude of competing explanations for the nature and origin of the material universe, everything from naturalism to pantheism, deism to theism. Let us initially compare the explanatory power of theism and naturalism, perhaps the two most influential worldviews in the West.

First theism, with its notion of a transcendent Creator, provides a more causally adequate explanation of the big bang singularity than a fully naturalistic explanation can offer. Since naturalism assumes that, in Sagan's formulation, "the Cosmos is all that is, or ever was or ever will be," naturalism denies the existence of any entity with the causal powers capable of explaining the origin of the universe as a whole.[101] Since the big bang in conjunction with general relativity implies a singular beginning for matter, space, time and energy, it follows that any entity capable of explaining this singularity must transcend these four dimensions or domains.[102] Insofar as God as conceived by Judeo-Christian theists possesses precisely such transcendent causal powers, theism provides a better explanation than naturalism for the singularity affirmed by the big bang cosmology. Theism also provides a better explanation for the origin of the universe than does pantheism, for much the same reason. Though a pantheistic worldview affirms the existence of an impersonal god, the god of pantheistic religions and philosophies exists within and is coextensive with the physical universe. God as conceived by pantheists cannot act to bring the physical universe into being from nothing (physical) since such a god does not exist independently of the physical universe. If initially the physical universe did not exist, the pantheistic god would not have existed either. If it did not exist, it could not cause the universe to exist.

Many scientists have acknowledged the challenge that the big bang theory poses for a naturalistic worldview. Thus many naturalistically minded

[101]Carl Sagan, *Cosmos* (New York: Random House, 1980), p. 4.
[102]Hawking and Penrose, "Singularities," pp. 529-48.

scientists—Einstein, Hoyle and Eddington, for example—either formulated alternative cosmological models to preserve an infinite universe or simply repudiated the big bang model on philosophical grounds. Most contemporary naturalists have adopted a slightly different approach. Many claim to have resolved the dissonance between the big bang theory and a naturalistic worldview by coupling the big bang theory to speculative quantum cosmologies or to many-worlds hypotheses. Yet ironically, to the extent that even these cosmological ideas may have validity, they themselves may also have latent theistic implications.[103] In any case, if the universe is finite, as the big bang and general relativity affirm, at least on the most straightforward rendering of each, then these theories provide confirmation of and epistemic support for the metaphysical hypothesis of theism. Further, theism provides a better, more causally adequate explanation for the evidence of a finite universe than its main metaphysical competitors. Hence, if we explicate epistemic support in terms of confirmation of hypothesis or explanatory power rather than deductive entailment, then the big bang theory provides support for theism and indeed for a Judeo-Christian understanding of creation.

While the big bang seems best explained by a transcendent cause, it may not by itself imply an intelligent or rational cause. Nevertheless, other types of scientific evidence may provide support for other attributes of a theistic God or a theistic worldview. Physics and cosmology suggest intelligent design as a highly plausible and arguably best explanation for the exquisite fine-tuning of the physical laws and constants of the universe and for the precise configuration of its initial conditions. Since the fine-tuning and initial conditions date from the very origin of the universe itself, this evidence suggests the need for an intelligent as well as a transcendent cause for the origin of the universe. Since God as conceived by Judeo-Christian (and other) theists possesses

[103]For example, on the standard Copenhagen interpretation of the so-called collapse of the wave packet, a wave function only acquires discrete values on observation. Thus, if the whole universe existed prior to Planck time as an (eternally existing) wave function as some quantum cosmologies suggest, the universe could not have acquired discrete characteristics until some "cosmic observer" had actualized one of its potential combination of states by observing it. See Richards, "Many Worlds," pp. 224-26; Plantinga, *Nature of Necessity*, pp. 213-17; Craig, "Barrow and Tipler," pp. 389-95; Craig, "Cosmos," pp. 26-27.

precisely these attributes, his creative action can adequately explain the origin of the cosmological singularity and the anthropic fine-tuning. Since naturalism denies a transcendent and preexistent intelligent cause, it follows that theism provides a better explanation than naturalism for these two evidences taken jointly. Since pantheism, with its belief in an immanent and impersonal god, also denies the existence of a transcendent and preexistent intelligence, it too lacks causal adequacy as an explanation for these evidences. Thus theism stands as the best explanation of the three major worldviews—theism, pantheism and naturalism—for the origin of the big bang singularity and anthropic fine-tuning taken jointly.

Admittedly theism, naturalism and pantheism are not the only worldviews that can be offered as metaphysical explanations for the classes of evidences discussed above. Deism, like theism, for example, can explain the cosmological singularity and the anthropic fine-tuning. Like theism, deism conceives of God as both a transcendent and intelligent Creator. Nevertheless, deism denies that God has continued to participate in his creation either as a sustaining presence or as an actor within creation after the origin of the universe. Thus deism would have difficulty accounting for any evidence of discrete acts of design or creation during the history of the cosmos (that is, after the big bang). Yet, precisely such evidence now exists in the biological realm.

Current fossil evidence puts the origin of life on earth at 3.5-3.8 billion years ago, clearly well after the origin of the universe. If the presence of a high information content in the cell provides compelling evidence for the intelligent design of the first life, then that suggests the need for an act of creative intelligence or a period of creative activity well after the big bang. One could argue against this by asserting that the information necessary to build life was present in the initial configuration of matter at the big bang. Yet the implausibility of such a view can be clearly demonstrated empirically.[104] On the other hand, theism can explain the origin of biological information as the result of God's creative activity, within a natural order

[104]Meyer, "Explanatory Power," pp. 113-47; Stephen C. Meyer, "Teleological Evolution: The Difference It Doesn't Make," in *Darwinism Defeated? The Johnson-Lamoureaux Debate on Biological Origins,* ed. Robert Clements (Vancouver, B.C.: Regent Publishing, n.d.), pp. 89-100.

that he otherwise sustains, at some point after his initial creation. Deism, on the other hand, cannot account for evidence of creation or design after the big bang since deism stipulates that God (the "absentee landlord") chose not to involve himself in the events or workings of the universe he created.

Interestingly, some philosophical naturalists have postulated an immanent intelligence as an explanation for the origin of the first life on earth. Francis Crick and Fred Hoyle, for example, have both proposed so-called directed panspermia models.[105] These suggest that life was intelligently designed (or seeded) by an intelligence within the cosmos—a space alien or extra-terrestrial agent—rather than by a transcendent, intelligent God. Thus their proposal suggests that even if the origin of life cannot be accounted for by a naturalistic process of chemical evolution, it can be explained by reference to a purely natural intelligence within the cosmos.

This explanation does not revive naturalism as an adequate metaphysical explanation for biological design, however, since no naturalistic explanations can account for the ultimate origin of specified biological information from simpler chemical constituents. Instead, it suggests that *if* naturalism could give an account of the origin of the specified complexity or information content required to make life somewhere, it might also be able to explain the origin of life at a specific time on earth. Yet naturalistic theories have failed precisely to explain the origin of the information necessary for life's origin. Thus, explaining the origin of life by reference to other life, albeit intelligent and extraterrestrial, only begs the question of the ultimate origin of life somewhere within the cosmos. In any case, naturalism has difficulty explaining other relevant evidences such as the cosmological singularity and anthropic fine-tuning as adequately or coherently as theism.

In 1992 the historian of science Frederic Burnham stated that the God hypothesis "is now a more respectable hypothesis than at any time in the last one hundred years."[106] Burnham's comment came in response to the discovery of the so-called COBE background radiation, which provided yet another dramatic confirmation of the big bang cosmology. Yet it is not only

[105]Francis Crick, *Life Itself* (New York: Simon & Schuster, 1981), pp. 95-166; Hoyle, *Evolution from Space,* pp. 24-51, 96-150.

[106]Frederic Burnham, quoted in David Briggs, "Science, Religion, Are Discovering Commonality in Big Bang Theory," *Los Angeles Times,* May 2, 1992, pp. B6-B7.

cosmology that has rendered the "God hypothesis" again respectable. A survey of several classes of evidence from the natural sciences—from cosmology, physics, biochemistry and molecular biology—finds theism emerging as a worldview with extraordinary explanatory scope and power. Theism explains a wide ensemble of metaphysically significant scientific evidences and theoretical results more simply, adequately and comprehensively than other major competing worldviews or metaphysical systems. This does not, of course, *prove* God's existence, since superior explanatory power does not constitute deductive certainty. It does suggest, however, that the natural sciences now provide strong *epistemological support* for the existence of God as affirmed by both a theistic and Christian worldview.