Introduction

The belief that the relationship of religion and science (or natural philosophy, as it was known until the late nineteenth century) has historically been one of conflict emerged during the eighteenth-century Enlightenment, with its hostility to religion and its valorization of science. In the latter half of the nineteenth century, it came to be widely held in North America by many non-specialist historians and scientists through the widespread influence of John William Draper and Andrew Dickson White (Draper, 1928 [1874]; White, 1896). It reflected a cultural shift in which science came to replace religion as an authoritative influence and to be viewed as the source of modern technology and prosperity. As the influence of religion declined, historians who studied the early contributors to the scientific revolution, such as Galileo Galilei, Johannes Kepler, and Isaac Newton—most of whom were deeply religious men—dismissed their religion as merely a private matter. This assumption fit comfortably into the twentieth-century presupposition that religion is only a private matter that has no larger bearing on science or culture generally.

In the last three decades of the twentieth century, several influential historians of science have provided a systematic reevaluation of the conflict thesis. In particular David Lindberg, Ronald Numbers, and John Brooke, among many others, have argued that the intersection of religion and science has been both more complex and less conflictive than is frequently depicted (Brooke, 1991; Brook & Numbers, 2001; Lindberg & Numbers, 1986). They address those who cite the trial of Galileo, the dispute over the theological implications of Charles Darwin’s theory of natural selection, and the Scopes Trial in America as evidence of the historical incompatibility of religious beliefs and scientific endeavor. The evidence suggests that the relations between religion and science in the Western tradition has not ordinarily been one of conflict but rather of a fruitful intersection that produced both mutual respect and harmony (Ferngren, 2000). Occasional tension emerged in periods of major scientific development, which Thomas Kuhn calls “paradigm shifts,” as well as in the ensuing debates over their implications for both science and religion. This chapter is written from the perspective that science and religion are not hostile to one another but complementary (Ferngren, 2017; Fleming, 2016). Together they provide a comprehensive understanding of the world in which we live and of our relationship to that world (Lindberg & Numbers, 2003).
The Copernican Revolution and Galileo

When joined with Aristotelian physics, the geocentric theory of the solar system, as refined by Ptolemy of Alexandria (second century CE), was almost universally accepted in the West and taken to be compatible with their theology by Jews, Muslims, and Christians until the seventeenth century. The first major challenge to the Ptolemaic theory came with the publication of Nicolaus Copernicus' (1473–1543) *De revolutionibus orbium coelestium* (*On the Revolutions of the Heavenly Bodies*), which appeared after the author’s death in 1543 (Copernicus, 1939 [1543]). Copernicus advocated a heliocentric model of the solar system. How he came to espouse it is unknown, but he might never have published it had it not been for the encouragement of a young Lutheran astronomer, Georg Rheticus (1514–1574) of Wittenberg. Although they initially rejected its heliocentric cosmology, Lutherans at the University of Wittenberg, including the Protestant Reformer Philip Melanchthon (1497–1560), were attracted to the mathematical convenience of the new theory. According to Michael Keas (and contrary to later popular mythology), it did not demote Earth from its previously exalted position in the center of the universe and challenge ideas of human centrality in the universe (Keas, 2015). Rather it promoted humans from their earlier position at the “bottom” of the planetary order (near hell in Dante’s cosmology) to a proximity to heaven that was ideally suited to astronomical observation of the universe. Elsewhere, however, Aristotelian natural philosophers in Europe rejected heliocentrism for a variety of reasons, many of which were scientific rather than theological. In the year 1600, there were probably no more than ten Copernicans in all of Europe.

One scientist who was quick to embrace the new theory was Galileo Galilei (1564–1642), a young professor of mathematics at the University of Padua. Although secretly a Copernican by 1597,
Galileo did not publicize his views until 1610, when in *Letters on Sunspots* he declared his acceptance of the heliocentric system. It was, however, his *Letter to the Grand Duchess Christina* (1615), in which Galileo argued that Scripture did not intend to impart scientific truth but accommodated itself to popular language in describing the natural world, which provoked the Catholic Church’s response (Galilei, 1989 [1615]). Although a layman, Galileo had undertaken to interpret the Bible, which only Catholic theologians were permitted to do. In the following year (1616), he appeared before the Congregation of the Holy Office (the Inquisition). Cardinal Bellarmine stated his willingness to accept the Copernican theory if it could be proven (which it could not be at the time); otherwise Scripture ought to be read literally as teaching geocentricity. The Catholic Church declared the theory “false and contrary to Holy Scripture” and recommended that *De revolutionibus* be “suspended until corrected.” Galileo was warned not to teach or defend heliocentrism except as a hypothesis until it could be proven (McMullin, 2005). In 1632, after maintaining silence for 16 years, Galileo published his *Dialogue on the Great World Systems*, a debate between proponents of the Ptolemaic and Copernican theories in which the arguments for the Ptolemaic theory were made to look feeble (Galilei, 1953 [1632]). Galileo was summoned to Rome, where he stood trial in 1633. Compelled to abjure his belief that the Earth moved, he was confined to a country estate near Florence, where he continued writing until his death in 1642.

The trial of Galileo must be understood against the backdrop of his own times (Biagioli 1993). The strong reaction against Copernicanism (and Galileo’s espousal of it) came from the Aristotelians of the scientific establishment, some of whom were determined to entangle Galileo with the church. In particular, Galileo aroused the ire of a loosely organized movement of traditional scientists called the *Liga*, which succeeded in introducing theological issues into scientific discourse and attacked Galileo for his views. In contrast with the relative freedom of intellectual debate that natural philosophers in European universities had enjoyed in the late Middle Ages, the Protestant Reformation had made the Catholic Church more cautious. On the question of whether Scripture ought to be read as teaching a geocentric universe, the church was anxious to prove its good faith in interpreting Scripture literally in the face of Protestant attacks on its allegorizing tendencies in biblical exegesis (Feldhay, 1995). Aristotelianism became, in its Thomistic form, a rigid dogma, and the papal court became, after the Council of Trent (1545–1563), more authoritarian in matters of biblical interpretation. The Inquisition and the Index of Prohibited Books, introduced into Italy by forces of the Counter Reformation, were employed against Galileo. The prosecution of Galileo represents not the *cause célèbre* in the alleged warfare of science with theology but a dispute that involved multiple issues, including powerful personalities and vested professional and ecclesiastical interests, which complicated Galileo’s championing of a revolutionary change in astronomical models (Numbers, 2009).

**The Mechanical Philosophy and Natural Theology**

The Copernican theory had come to be widely accepted throughout Europe by the mid-seventeenth century, owing largely to Galileo’s promotion of heliocentrism. It resulted in the formulation of a mechanical model of the universe, which attempted to account for all natural phenomena of matter and motion without reference to divine action. The mechanical philosophy explained physical phenomena by the interaction of tiny particles of matter called atoms. Several leading figures of the scientific revolution adopted one or another element of the model, but René Descartes (1596–1650) and Pierre Gassendi (1592–1655) sought to build on the basis of corpuscular materialism a new philosophy to replace the Aristotelian model. Descartes and Gassendi based their mechanical philosophies on theological principles, while others adopted more radical views, as their critics feared would happen. Thomas Hobbes (1588–1679) became a materialist and Voltaire (1694–1778) a deist.

It was Isaac Newton (1643–1727) who created the greatest synthesis of the mechanical philosophy in his *Principia Mathematica Naturalis Philosophiae* (*Mathematical Principles of Natural Philosophy* [1687]),
(Newton, 1934 [1726]). By his discovery of the principle of universal gravitation, Newton succeeded in harmonizing celestial and terrestrial mechanics. In so doing he brought, for the first time, the whole of nature into a precise rational interpretation. Without recourse to primary causes, Newton’s picture of a universe governed by uniform laws resulted in the growing belief that nature was self-governing. The Newtonian picture allowed some to create the “natural religion” of Deism, in which God was described in natural rather than theological terms as a Craftsman, a Geometer, or an Architect, all using clockwork metaphors. He was disengaged from the universe and had no control over human affairs. But Newton was not a deist, and although he feared these potential views, he remained a theist who rejected the clockwork metaphor. Newton was himself a Christian (although likely an Arian), but he inadvertently laid the groundwork for the rationalism of the eighteenth-century Enlightenment (Harrison, 1998). Building on his synthesis, David Hume (1711–1776) developed a materialistic philosophy in Scotland, while philosophers like Julien Offray de La Mettrie (1709–1751) and Baron d’Holbach (1723–1789) embraced atheistic materialism in France.

In the latter half of the seventeenth century, the popularity of the mechanical philosophy led to the formation of a natural theology that continued into the nineteenth century. It is by means of knowledge derived from natural reason rather than from special revelation that natural theology defines the existence and attributes of God. Several scientific discoveries provided reasons for its attractiveness: the wonders of scientific discoveries, many of which were revealed for the first time with the invention of the microscope; the growing desire to build an adequate foundation for a theology of divine providence that would provide evidence against the fear of materialistic atheism; and the virtually universal acceptance of Newton’s mechanical picture of nature. The cornerstone of natural theology became the argument from design. Not all exponents of natural theology were Deists or materialists; many were theists who reacted to Puritanism by demonstrating the majesty of the Creator from the intricacies embedded in his creation. In William Paley’s (1743–1805) influential *Natural Theology, or Evidences of the Existence and Attributes of the Deity* (1802), natural theology reached its apex and deeply influenced, among many others, young Charles Darwin (Paley, 1802).

**Geology and Evolution**

The Enlightenment exalted reason and rejected special revelation, and its influence was notable in the developments that were occurring in the sciences. As theological themes diminished, there was an increasing tendency to seek naturalistic explanations and to divorce theological arguments and constraints from science. In what came to be termed “physico-theology” in the seventeenth and eighteenth centuries, theories of the Earth had sought to weave together geology and theology (Gil- lispie, 1996). Many of these theories calculated the age of the Earth by using biblical chronologies that could be harmonized with physical evidence to postulate a young Earth. Most dated organic fossils to Noah’s flood, although it was becoming increasingly difficult by the eighteenth century to account for the global distribution of fossils by a single flood that had taken place only a few thousand years before. Georges Louis Leclerc, Comte de Buffon (1707–1788), was a French naturalist and deist who publicly proposed the age of the Earth at 75,000 years and privately suggested that it might be as old as three million years. He maintained that each of the six biblical days of Creation in Genesis might represent an immense length of time. Georges Cuvier (1769–1832), a devout Protestant, demonstrated the existence of fossil mammals that were unlike any in his own day and without any apparent intermediate forms. He argued that a series of geologic catastrophes had eliminated species in past ages. Cuvier’s views did not derive from his religious convictions, and in any event, his catastrophes were not global. They were later read as global, however, and were appropriated in English natural theology to support theories of catastrophism, which became a popular form of physico-theology that attributed geological changes to great catastrophes of the past, the most recent being the biblical flood.
The Scottish geologist Charles Lyell (1797–1875) altogether rejected providential interventions in geologic history. In his *Principles of Geology* (3 vols., 1830–1833), he succeeded in severing geology from theology (Lyell, 1990–1991 [1830–1833]). Lyell rejected diluvialism and catastrophism for what became known as uniformitarianism: the theory that geological changes on the Earth’s surface have occurred slowly over long periods of time and that in explaining change, we refer to processes that we currently observe. Previous proponents of diluvialism, like William Buckland (1784–1856) of Oxford and Adam Sedgwick (1785–1873) of Cambridge, quickly abandoned catastrophism and adopted the new geology, which Christians harmonized with the Genesis account of creation in a relatively painless fashion. A group of laymen, who called themselves Mosaic or Scriptural geologists, continued to take their geology from Genesis, but they were quickly marginalized since nearly all professional geologists abandoned the Noachian Flood as an organizing idea in accounting for changes in the Earth’s history.

Charles Darwin (1809–1882) had been strongly influenced by Paley’s natural theology. During his voyage aboard the HMS *Beagle*, however, he read Lyell’s work and began to think that slow changes had produced the geological phenomena that he observed. His theory of evolution by natural selection, published in *Origin of Species* (1859), made use of Lyell’s theories that the Earth was very old and the fossil record imperfect (Darwin, 1952 [1859, 1872]). Evolutionary ideas had preceded Darwin. Originating in the Enlightenment, they had already been proposed in the eighteenth century by Charles’ grandfather, Erasmus Darwin (1731–1802), and by Jean-Baptiste Lamarck (1744–1829), the latter proposing the theory that acquired characteristics were inherited. By the mid-nineteenth century, the belief that some form of transmutation (evolution) represented a divine plan was widespread. In advancing natural selection as a mechanism for evolution, Darwin argued that, in the “struggle for existence,” those individuals with even a slight advantage would survive and pass their advantage on to their offspring. Herbert Spencer (1820–1903) referred to it as the principle of the “survival of the fittest.”

Darwin’s theory met with a mixed response that cut across conventional professional and religious boundaries. Some natural philosophers initially rejected it, while a number of Protestant clergymen accepted it. Conservative anti-Darwinists, including several leading naturalists like Louis Agassiz of Harvard (1807–1873), geologists like Canadian William Dawson (1820–1899) of McGill, and theologians like Charles Hodge (1797–1878) of Princeton Seminary, rejected it, fearing the break with final causes. A second group of Christians accepted evolutionary theory as compatible with a biblical faith. They included the Scot James McCosh (1811–1894), president of Princeton University, and the American botanist Asa Gray (1810–1888) of Harvard. A third group came to believe that evolution had rendered supernatural religion untenable and opted (most often) for some form of philosophical materialism (Moore, 1979; Numbers, 1998; Durant, 1985).

By the 1870s, however, most scientists and a large body of the educated public had accepted some form of evolution, though not necessarily by natural selection, since Lamarck provided an earlier and alternate version. Full acceptance of Darwin’s views on human nature, as set forth in his *Descent of Man* (1871), was more difficult for Christians and many others. Darwin maintained that moral values were rationalizations of social instincts that had developed by natural selection, thus asserting a full-blown materialism. Other scientists of a variety of religious and nonreligious views, such as Alfred Russel Wallace (1823–1913), the co-discoverer of the theory of evolution by natural selection, rejected materialism, maintaining that the creation of the human mind required nonmaterial forces.

Debate among Christians and even among non-Christians over Darwin’s theory of natural selection continued throughout the nineteenth and well into the twentieth century. The Roman Catholic response was initially negative but by the 1920s, a number of distinguished Catholics, clergy and
scientists had begun to accept an evolutionary point of view (Artigas, 2006). The most controversial Darwinist in the Roman Catholic Church was Pierre Teilhard du Chardin (1881–1955), a Jesuit who advocated a radical theological system based on evolutionary principles. In 1950, Pope Pius XII expressed a cautious acceptance of evolution in his encyclical *Humani generis* (O’Leary, 2006; McMullin, 1985). Among Protestant Christians the discussion most often reflected hermeneutical issues, especially a difference in biblical interpretation between those who took the Creation account in the first chapter of Genesis literally and those who took it figuratively. For some, such as William Jennings Bryan (1860–1925), it was less a question of biblical literalism than a rejection of the philosophical materialism implicit in Darwin’s theory of natural selection. Darwin’s reductionist explanation led to Bryan’s conclusion that the imperialism and militarism witnessed in World War I were the inevitable result of an amoral theory of the survival of the strongest. These issues informed the cultural backdrop of the Scopes trial, held in the small town of Dayton, Tennessee, in 1925, in which a 24-year-old teacher, John Scopes, who did not teach biology and had never taught evolution, volunteered to stand trial (Larson, 1998). It was arranged by the American Civil Liberties Union (ACLU) as a show trial that was intended to embarrass Christian conservatives by depicting their views as a manifestation of nativist anti-intellectualism. Civic leaders of Dayton welcomed the expected publicity of what they termed the “trial of the century.” Bryan, who opposed evolution on religious and humanitarian grounds, volunteered to testify for Scopes’ prosecutors, while Clarence Darrow (1857–1938), probably the best-known trial lawyer in the United States, offered to defend Scopes. Both were renowned orators, and Bryan had been a three-time populist candidate for president on the Democratic ticket. The trial lasted for eight days and received national coverage in the media, which portrayed the prosecution as a reactionary attempt of southern know-nothings to hinder scientific progress. It was later depicted as such in the book, later made into a popular film, *Inherit the Wind* (1960), which caricatured religious opposition to the theory and contributed to shaping the subsequent interpretation of the trial. The Scopes Trial did much to divide Americans over the theory of evolution, acceptance of which became an article of faith among educated classes, as did opposition to the theory among many religious fundamentalists. Both views remain issues of controversy today.

Social Darwinists adapted Darwin’s theory to cultural and social issues, which came to dominate colleges and universities. Beginning in the 1920s, Christians who maintained an anti-evolutionist position pursued a rearguard crusade against Darwinism that gained support in conservative Protestant circles. Most prominent were George McCready Price (1870–1963) and Harry Rimmer (1890–1952), whose prolific writings attacked evolution on religious and scientific grounds. But the fundamentalist anti-evolution attack remained a backwater until the late 1960s, when it emerged as a cohesive movement that became known as “scientific creationism” with the publication of *The Genesis Flood* by John C. Whitcomb (an Old Testament scholar) and Henry M. Morris (a hydraulic engineer) in 1961 (Whitcomb, 1961; Numbers, 2006). The book revived the theory of “biblical geologists” of the early nineteenth century that accounted for the geological formations of the Earth’s surface by a worldwide flood, the biblical Noachian Deluge, which had occurred no more than a few thousand years before the present. Although it was not accepted by more than a very small minority of professional geologists, its proponents organized the Creation Research Society in 1963 to encourage research and publications that advocated a young-Earth view of Creation and to popularize their position in fundamentalist churches in North America. Because of its theistic and non-secularist assumptions, it later came to enjoy some acceptance as well in Islamic circles outside America. The end of the twentieth century saw the development of Intelligent Design (ID), a religiously motivated challenge of the fundamental principles of modern science. ID attempts to renew the old argument from design by drawing attention to phenomena that seemed inexplicable from a naturalistic perspective (Behe, 1996; Dembski, 1998; Dembski & Ruse, 2006).
The Modern Synthesis in Evolution

The Modern Synthesis in evolution developed as an attempt to reconcile Darwinian natural selection with Mendelian genetics. Between 1915 and 1930, laboratory genetics, spearheaded by Thomas Hunt Morgan (1866–1945), came to provide its empirical foundation, while several British theoretical biologists constructed appropriate mathematical theories of population genetics. Between 1937 and 1945, J. B. S. Haldane (1892–1964), George Gaylord Simpson (1902–1954), Julian Huxley (1894–1963), and others explored its implications for paleontology, zoology, cytology, and botany. While they came from a variety of philosophical and religious backgrounds, and several were materialists, none of the prominent scientists who pioneered the Modern Synthesis thought that it necessarily required atheistic, reductionist, materialist, or dysteleological assumptions. Even Julian Huxley, an agnostic, acknowledged the metaphysical reality of a force driving the progress of evolution, and some biologists involved in the formulation of the Modern Synthesis, such as Ronald Fisher, Sewall Wright, Theodosius Dobzhansky (1900–1975), and Francisco Ayala (b. 1934), drew parallels between evolutionary progress and the progression of humanity from sin to eternal redemption. Several, such as Dobzhansky and Ayala, were practicing Christians, and it was Dobzhansky’s Orthodox Christian faith that initially attracted him to the theory of evolution.

The New Atheism

The past century has witnessed a dramatic transition from an assumption that God created and governed the world to a widespread acceptance of atheism, which was accompanied by a materialist worldview. The relative historical positions of science and religion were turned on their heads in the late nineteenth century, when science replaced religion as the dominant cultural authority, chiefly as a result of the publication of Darwin’s *Origin of Species* (1859), which undercut the religious roots of Western societies by introducing a non-theistic naturalism into the sciences generally. Many researchers became advocates of evolutionary naturalism and abandoned belief in God or in divine interaction with nature. The greatest influence of the theory of evolution on science, however, was that it professionalized science and recast society as privileging scientific inquiry over religion. Within a generation after Darwin, the close link that had existed between religion and the sciences since the Middle Ages largely ceased to exist.

Perhaps the most notable recent case of Darwin’s theory of natural selection being conducive to promoting an anti-religious worldview has been the New Atheism, as it has come to be called. The New Atheism is not merely a revival of earlier manifestations of agnostic or rationalist belief, such as one finds among Deists in the eighteenth century and Victorian rationalists in the nineteenth. Its stance is aggressively anti-religious, tending to regard religious belief as morally evil rather than simply mistaken. Its proponents insist, moreover, that a true scientist must be an atheist because religious believers are unable to think correctly or to make proper judgements. Leading atheists like Richard Dawkins (b. 1941) in Britain and Daniel Dennett (b. 1942) in America grounded their atheism in Darwin’s ideas (Dawkins, 2006). Both believe that morality can and must be based on materialist principles and that God is merely a scientific hypothesis whose existence can be tested and falsified empirically. They claim, moreover, that belief in God is a dangerous idea that promotes religious terrorism. Religion allegedly produces not only superstition but mind control and delusion. Dawkins has attempted to establish scientific support for his view by postulating a hypothetical “selfish gene,” the result of genetic mutation, whose preservation provides a naturalistic explanation of altruism (Dawkins, 2016). Altruism was for Dawkins merely a stratagem that evolved by a blind, unconscious, and mechanical process, to ensure the optimal survival of one’s genes. It was a form of selfishness that raised or lowered one’s prospects of survival. Pure, disinterested altruism had no
place in his world of nature and never would. In this respect, Dawkins adopted a variant of Thomas Hobbes’ (1650–1685) theory that altruism is merely a form of enlightened self-interest. Blaming one’s genes relieves humans of personal moral responsibility and provides a convenient excuse for antisocial behavior.

Basic to Dawkins’ New Atheism is scientism, the belief that the scientific method is the only reliable source of knowledge. Hence morals, ethics, human behavior, and social concepts must all be subject to empirical approaches to knowledge. Having its origins in the Scientific Revolution and its growing emphasis on reason, the scientism of Dawkins has come to elevate empiricism and naturalism over traditional epistemologies that are rooted in metaphysics, religion, philosophy, and the humanities. It claims superiority over all other disciplines and ways of knowing and restricts human inquiry to the confines of the scientific method. It rejects the legitimacy of any transcendent, spiritual, or intuitive foundations of knowledge and maintains instead that science provides the sole or best answer to any question a human can ask. It, therefore, recognizes no limitations on science.

Indeed, materialism has for Dawkins and the New Atheists assumed something of the character of a religion in making exclusive claims. The New Atheists argue that religious views are anti-rationalistic and cannot stand up to scientific investigation. This inversion is ironic because of the close relations that had traditionally existed between natural theology and the sciences in mainstream European thought until the middle of the nineteenth century. Natural theology was widely believed to argue for the existence of God and for special creation of the material universe. Many natural theologians believed that God could be known through natural reason quite apart from special revelation. The universe gave the appearance of an intelligible order and design, which in turn provided evidence of a transcendent designer. This assumption led natural philosophers and mathematicians, such as Copernicus, Kepler, and Newton—who were Christians, to believe that their scientific exploration glorified God. Johannes Kepler (1571–1630), who abandoned the study of theology for astronomy, justified the change in his professional vocation by stating that he wanted to think God’s thoughts after him. In contrast, science is seen today by the New Atheists as demanding religious skepticism.

Yet despite its claims to be objective and “scientific,” the scientism of the New Atheists is a philosophical position, unable to be proven by the method that it advocates (McGrath, 2004; 2009). Like other epistemological perspectives, it cannot demonstrate its own validity. In order for scientism to have legitimacy in its claims, it would have to withstand the rigorous test of the scientific method, which necessitates the consideration of competing philosophies as potentially valid. Whether one does or does not believe in a god, or in a divine order and purpose for the universe, there is no way to demonstrate either view scientifically. Both theism (belief in a personal God) and atheism rest on assumptions that are intertwined with the personal faith of the person who holds them. Thus, when Carl Sagan (1934–1996) writes in Cosmos, “The Cosmos is all that is or ever was or ever will be,” he makes a statement of his personal faith, not of his investigation of science (Sagan, 1980). Equally true is the view of the Harvard evolutionary biologist E. O. Wilson (1929–2021), founder of the fields of sociobiology and biodiversity. Wilson writes in Consilience, “We can be proud as a species because, having discovered that we are alone, we owe the gods very little (Wilson, 2014: 271).” Here again Wilson’s assertion is not a conclusion based on empirical or rational evidence, since there is no clearly demonstrable evidence that permits us to decide whether we are alone in the universe. But methodological naturalism (the assumption that the laws of nature are limited to the search for natural causes) does not require metaphysical naturalism (the assumption that there is no primary or supernatural causation). Scientism narrows rather than expands human inquiry by rejecting out of hand other approaches to knowledge that offer the possibility of understanding whether the universe has meaning.
Twentieth-Century Physics and Cosmology

From about 1895, modern physics began to deal with issues that went beyond those of classical physics, particularly quantum mechanics and special and general relativity. The introduction of quantum theory challenged the determinism of the mechanical picture of Newtonian physics (Drees, 1990). The central features of quantum theory were developed separately in 1926 by Werner Heisenberg (1901–1976) and Erwin Schrodinger (1887–1961). The indeterminacy principle of Heisenberg demonstrated that one could not know perfectly both the position and the momentum of a subatomic particle. Heisenberg’s principle gave rise to much discussion of its wider philosophical and theological implications. Albert Einstein (1878–1955) never brought himself to accept quantum mechanics, asserting that “God doesn’t play dice with the universe.” The quantum physicist John Polkinghorne (1930–2021) has argued that the discovery that physical processes are unpredictable, both at the microscopic level of quantum theory and at the macroscopic level of chaos theory, has brought about the demise of a mechanical and deterministic picture of the universe (Polkinghorne, 2005a). Polkinghorne believes that this demise offered space for God’s immanence to operate through natural law in providential action in place of a deistic belief in a God who is not involved in superintending his creation (Russell et al., 1995, 1988).

The first half of the twentieth century witnessed equally significant changes that challenged conventional theories of the origin of the universe dating from the eighteenth century. The American astronomer Edwin Hubble (1889–1953) discovered on the basis of the spectral red shift that the universe was expanding at an enormous rate. His discovery led to the Big Bang theory, formulated by Georges Lemaître (1894–1964), a Belgian Catholic priest and theoretical physicist, who proposed that the universe began as a “primeval atom” of dense matter that had exploded in the far distant past (Godart, 1985; Kragh, 1987). Although Lemaître did not make claims for special (divine) creation on the basis of his theory and always insisted on keeping his scientific work separate from its religious implications, the fact that he was a Catholic Christian delayed its widespread acceptance. The theory found resistance among some astrophysicists, who believed that Lemaître was influenced by a desire to find a theory for the beginning of everything that would be compatible with his theological belief in divine creation. The British astrophysicist Fred Hoyle (1915–2001), an atheist who suspected a religious agenda in what he dismissively termed the “Big Bang,” proposed an alternative, the steady state theory. Hoyle maintained that the universe was eternal, with matter being continuously created in space. Given the widespread resistance to Lemaître’s theory over several decades, the Big Bang required further evidence to give it scientific standing. Between 1946 and 1953, George Gamow and other researchers worked out the implications of the theory, and by the 1960s, observational discoveries resulted in its widespread acceptance. In spite of Lemaître’s own modest reluctance to draw theological conclusions, some prominent astrophysicists claimed that the Big Bang theory lent credibility to the biblical account of God’s special creation of the universe (Matt, 1996).

The twentieth century was productive of other cosmological theories, several of them with theological implications. Perhaps the most notable is the anthropic principle, which suggests that the emergence of humans in the universe is not an accidental by-product of purposeless cosmic evolution (Barrow & Tipler, 1986). According to this theory, the universe is barely fit for survival. If several basic physical constraints had been slightly different at the beginning, it would have been impossible for human life to have arisen. Hence the anthropic principle (of which there are several variants) suggests that the universe is finely tuned for humans, who were not merely an accident of a purposeless universe. The anthropic principle reintroduced into cosmological speculation issues that scientists had earlier laid to rest, including questions of teleology and divine providence (Polkinghorne, 2005b; Gingerich, 2006).

Without other means of knowing, any inference for belief in the existence of a divine force would be questionable, given the fact that cosmology, like much of science, is in itself value-free
and can be called upon to support different theologies and belief systems: theism, atheism, Deism, pantheism, and process philosophy. It can be viewed through a theistic or a materialist lens. While many biologists have used their studies of evolution to argue against belief in a personal God, the reverse is broadly true of cosmologists. Several prominent cosmologists have contended that the data demonstrate the existence of a god. British cosmologists, such as Paul Davies in his book *God and the New Physics* (1983), argues that cosmology and religion address the same questions. And while some American cosmologists have ignored the religious implications of cosmology, others, such as Arno Penzias, a devout Jew and co-discoverer of microwave background radiation, have explored or supported them. In *The Physics of Immortality* (1994), Frank Tipler uses cosmological arguments to support his belief in the existence of God and belief in an afterlife (Tipler, 1994). The agnostic Jewish astronomer Robert Jastrow, head of NASA, wrote a well-received book that discusses the theological implications of cosmology, *God and the Astronomers* (Jastrow, 2000). George Ellis co-authored *On the Moral Nature of the Universe* with theologian Nancey Murphy (Murphy & Ellis, 1996). Ellis is not an American, but he is a distinguished figure in science, and his treatment of the subject reveals a not-incompatible deep faith.

**The Intersection of Faith and Reason**

In spite of the work of John Brooke, Peter Harrison, John Polkinghorne, and others in the past generation who have argued that the alleged historical conflict of science and religion is a myth, there is a widespread view today among both scientists and the lay public that they are opposed to one another. The natural sciences in the Western world today assume an atheistic or, minimally, an agnostic approach. Yet there is nothing inherently scientific about atheism. Atheists have simply appropriated science and used it for their own apologetic purposes by arguing that natural causes are sufficiently explanatory in themselves and do not require primary causes.

Underlying this metaphysical naturalism is the widespread assumption that modern science has disproved traditional religious beliefs, particularly those that require the existence of a supernatural order, such as the plausibility of miracles. This assumption has created a worldview that has made it more difficult for many to believe in God or in the immortality of the soul. But surely the preliminary issue here is whether God exists. If one assumes that there is a God who is transcendent—outside the universe and above nature—then it is hard to deny his power to perform miracles. And here we confront the allegedly irreconcilable difference between faith and reason. The widespread modern view is that science is based solely on reason and is therefore rational, while religion is based solely on faith and is therefore irrational. But the operative assumptions underlying this alleged dichotomy reflect as well the personal beliefs and assumptions of the philosopher or scientist, a factor that is often ignored in discussions of science and religion.

I am unable [writes the Cambridge historian Herbert Butterfield] to see how a man can find the hand of God in secular history, unless he has first found that he has an assurance of it in his personal experience. It only becomes effective for those who have carried the narrative to intimate regions inside themselves, where certain of the issues are brought home to human beings. In this sense our interpretation of the human drama throughout the ages rests finally on our interpretation of our most private experience of life, and stands as merely an extension to it (Butterfield, 1950: 107).

The difference that Butterfield finds between the views of those who see a providential order in history and those who see history as wholly contingent is operative as well in science where, far from being mutually exclusive, faith and reason are arguably mutually supportive. Science as an explanatory enterprise cannot convincingly offer a rationally coherent explanation of how human
life evolved in a universe that is the contingent and unguided result of natural processes. Hence, faith plays a complementary role in accounting for how a meaningful purpose came to exist—how, for example, apparently random mutations occur that give evidence of complexity and integration. Such an explanation cannot be tested empirically yet points beyond the realm of nature to purpose that operates through natural causes. The evidence for purpose does not reside in a universe that, having been determined solely by chance, is uniform and undifferentiated, impersonal and meaningless. It can be perceived, experienced, enjoyed, and studied by humans who have not merely the powers of perception but also the cognitive abilities to describe and understand it. They have as well a spiritual perception that sees beyond the world of matter to a God who lies outside nature and who both created and sustains it. It is not a perception that lies solely in the eye of the beholder but may be found in the grandeur of the natural world, which testifies to its creator through the lens of faith.

One might say, moreover, that without a faith perspective, researchers can explain how things happen, but they cannot tell us whether they have any broader significance. Faith gives meaning to events. As human beings we have an insatiable curiosity to know, as Aristotle famously remarks in the opening sentence of his *Metaphysics*. Not merely to know how but to know why. Many of us will never be satisfied with an understanding of how the universe operates if we have no means of determining why it exists and what the purpose of life in the universe is—if indeed there is any. It is rather like being content to understand the mechanism of a clock without expecting it to tell time. The seventeenth-century French mathematician Blaise Pascal (1623–1662) wrote that when he looked up at the sky, he perceived only the eternal silence of infinite space. “And when I contemplate that silence,” writes Pascal, “I am afraid.” If the universe offers no answers to our ultimate questions, if we look up at the sky and hear only silence, then we too are inclined to be afraid.

“Le cœur a ses raisons, que la raison ne connaît point” (“The heart has its reasons, of which reason knows nothing”), writes Pascal elsewhere. The reasons of the heart involve the world of the spirit, which is seen in those feelings that give meaning and pleasure to life: love, devotion to a cause, altruism, the aesthetic and emotional satisfaction that we find in music and the arts. But the life of the spirit is seen most profoundly in religious expression, and it is most notably at this level that science fails to provide satisfying answers. It is not surprising that the last decade of the twentieth century has seen a resurgence of interest in the relationship of religion and science. This interest arose from a variety of sources both inside and outside the scientific community. It can be seen among Christians, Jews, Muslims, and those of other theistic traditions, who have most often argued for the complementarity of religion and the sciences, but also among process philosophers, proponents of New Age and pantheistic spirituality, and non-Western religious traditions. It reflects the widespread recognition that, for all its achievements, science does not—indeed cannot—provide ultimate answers to questions regarding the meaning of the universe or of life itself.

It is religion, not science, which provides us with the keys to understanding the meaning of life. It informs our personal relationships and infuses our culture. Religion has inspired great beauty in art, architecture, and music: a transcendent perspective that enhances the natural world. Even those of a determinedly secular outlook often find those cultures of the past that are rooted in the deepest moral and religious values of human experience worthy of their study and often of their appreciation. Past cultures intersect with spiritual values across the centuries, and they suggest a continuing transcendent understanding of our own experience. Lacking a spiritual component, secular science naturally tends toward reductionism and sometimes toward ugliness in the arts since its denial of a spiritual component in man provides few underlying mystical or otherworldly values that transcend the merely utilitarian. Science, moreover, cannot give answers to the greatest problems that bedevil life: the problems of pain and suffering and of moral evil. Philosophy allows us to define the questions, but it offers a multiplicity of competing answers, each of them the contribution of a particular school of philosophy, answers that are recycled through the centuries but never finally resolved. Hence many who seek answers in science to the deeper questions of life eventually abandon the
search and become sceptics, agnostics, materialists, or atheists, whose philosophies lack a positive creed. And especially where the most intractable problems are concerned—the problems of moral evil, suffering, and life after death—they come to resemble Socrates standing after his death at the River Styx, asking questions to which he receives no answers.

Religion allows us to view a larger picture; it deepens and corrects our limited understanding, and it provides context and meaning that reason alone cannot provide. Faith does not replace reason but complements it. Medicine provides a familiar example. Medicine is an applied art based on a rational understanding of how nature works in the human body. Its purpose is to heal disease and to relieve human suffering. But medicine cannot explain suffering. That is the role of religion, which aids in our understanding and, more particularly, in our acceptance of suffering. Physicians and the clergy have long recognized the overlapping and mutually supportive relationship of medicine and religion. Cotton Mather (1663–1728), a leading Boston minister in Puritan New England, publicly advocated variolation for smallpox when most physicians advocated against it because of its potential danger as an experimental procedure. Mather termed the cooperation of medicine and religion an “angelical conjunction.”

If the concept of a harmony between medicine and religion provides one perspective of their relationship, it is not the only one. Faith also provides a necessary framework within which science can be approached—not only in its understanding of nature, but also in the uses to which it puts that understanding. Those systems in history that have attempted to derive the principles of human morality and ethics from nature alone have too often championed the superiority of power and force over the weak. One sees this in the debate in Greece of the fifth century BCE between the Enlightenment-based proponents of physis (“nature”) advocated by the Sophists and nomos (“convention, law”) championed by Socrates. In his Melian dialogue, the fifth century BCE historian Thucydides (History 5.84–116) illustrates this dichotomy by providing an example of the claims of the strong to possess by nature the right to do whatever they wish to the weak, who are condemned to suffer what they must. One sees it in modern times in the encouragement that Social Darwinists provided for European imperialism, militarism, and racism in the late nineteenth century, as well as in the eugenics movement that led in the early twentieth century to widespread legislation to require sterilization, sexual segregation, and marriage restrictions of the mentally unfit in the name of science. Its advocates cited allegedly progressive science to support their views. Since Francis Bacon (1561–1626) argued that knowledge is power, science has furnished an effective means of gaining or justifying power. Hence, it requires a framework that provides moral limits to the unrestrained use of force. That framework comes best from transcendent values that insist that the autonomy of scientific research must be recognized and protected. But they also demand that the use of that research must always fall within moral constraints that are best safeguarded by a higher law. Contrary to the aphorism of the Greek sophist Protagoras (c. 490–c. 420 BCE), man is not “the measure of all things, of those that are, that they are, and of those that are not, that they are not” (Plato, Theaetetus, 160d). That measure belongs to God, who has placed within the structure of humanity the values of love, compassion, and mercy. It is those values that make us fully human. A truly decent society cannot be built on the belief that humans are mortals whose ethical systems are merely rationalizations of herd instincts inherited from their hominoid past. While moral variety can be found among human cultures, together with the idealization of very different virtues, one finds a nearly universal condemnation of many of the same moral evils that points to transcendent standards. Nor does pluralism necessarily entail moral relativism. Humans are moral beings whose language and society are those of shared moral universals that are most securely rooted in the faith traditions that teach them the limits of their reason and provide the values by which they live (Polkinghorne, 1994, 2001).

Sir William Bragg (1862–1942), a Nobel laureate, likened the relation of science and religion to the cooperation of the thumb and the fingers. They are, he said, functionally and spatially opposite, but it is precisely by means of their opposition that they are able to grasp a wide variety of objects (Grant, 1952: 43). Science and religion are not adversaries. They do not offer alternative and competing views
of nature. But they are different, and indeed they complement one another. When each fulfills the role that is intended for it, they enhance one another. On the other hand, when scientists make dismissive statements about religion, or the defenders of religion make dismissive statements about science, they impinge upon one another’s domain and thereby invite conflict. During the past two millennia, religion and science have far more often been in harmony than they have been in conflict, each doing what the other could not. In their fruitful opposition, they have provided a comprehensive view of nature and, in so doing, have enlarged the human mind and exalted the human spirit.

Note

1 I would like to thank my friend and university colleague Prof. P. Andrew Karplus for his insightful comments and additions to this article, as well as Joy McMurchy for her assistance in preparing it for publication.

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