Introduction

In a classic discussion of the origins of modern science, the historian Herbert Butterfield drew a much-quoted parallel. Such was the impact of the seventeenth-century Scientific Revolution that the only landmark with which it could be compared was the rise of Christianity. In shaping the values of Western societies, science and the Christian religion had each played a preeminent part and made a lasting impression. Exaggerated or not, such comparisons raise an obvious question. What was the relationship between these powerful cultural forces? Were they complementary in their effects, or were they antagonistic? Did religious movements assist the emergence of the scientific movement, or was there a power struggle from the start? Were scientific and religious beliefs constantly at variance, or were they perhaps more commonly integrated, both by clergy and by practicing men of science? How has the relationship changed over time?

Such questions are easier to formulate than to answer. Since the seventeenth century every generation has taken a view on their importance without, however, reaching any consensus as to how they should be answered. Writing some sixty years ago, the philosopher A. N. Whitehead considered that the future course of history would depend on the decision of his generation as to the proper relations between science and religion – so powerful were the religious symbols through which men and women

conferred meaning on their lives, and so powerful the scientific models through which they could manipulate their environment. Because every generation has reappraised the issues, if not always with the same sense of urgency, there has been no shortage of opinion as to what that proper relationship should be.

In popular literature three positions are commonly found, which, though not equally unsatisfactory, turn out to be problematic. One often encounters the view that there is an underlying conflict between scientific and religious mentalities, the one dealing in testable facts, the other deserting reason for faith; the one relishing change as scientific understanding advances, the other finding solace in eternal verities. Where such a view holds sway, it is assumed that historical analysis provides supporting evidence – of territorial squabbles in which cosmologies constructed in the name of religion have been forced into retreat by more sophisticated theories coming from science. The nineteenth-century scholars J. W. Draper and A. D. White constructed catalogs of this kind, in which scientific explanations repeatedly challenged religious sensibilities, in which ecclesiastics invariably protested at the presumption, and in which the scientists would have the last laugh.

Typical was White's account of the reluctance of the clergy to fix lightning rods to their churches. In 1745 the bell tower of St. Mark's in Venice had once again been shattered in a storm. Within ten years, Benjamin Franklin had mastered the electrical nature of lightning. His conducting rod could have saved many a church from that divine voice of rebuke, which thunder had often been supposed to be. But White reported that such meddling

FIGURE INT.1. Francesco Guardi (1712–93), *Venice Piazza San Marco*. Dating from c. 1760, this painting shows St. Mark's Cathedral and its bell tower. Reproduced by courtesy of the Trustees, The National Gallery, London.

with providence, such presumption in controlling the artillery of heaven, was opposed so long by clerical authorities that the tower of St. Mark's was smitten again in 1761 and 1762. Not until 1766 was the conductor fixed – after which the monument was spared. White's picture of religious scruples and shattered towers symbolizes the popular notion of an intrinsic and perennial conflict. An ounce of scientific knowledge could be more effective in controlling the forces of nature than any amount of supplication.

A second, quite different view also appeals to history for its vindication. Science and religion are sometimes presented not as contending forces but as essentially complementary – each answering a different set of human needs. On this view, scientific and theological language have to be related to different spheres of practice. Discourse about God, which is inappropriate in the context of laboratory practice, may be appropriate in the context of worship, or of self-examination. Historical analysis is often invoked to support this case for separation because it can always be argued that the conflicts of the past were the result of misunderstanding. If only the clergy had not pontificated about the workings of nature, and if only the scientists had not been so arrogant as to imagine that scientific information could meet the deepest human needs, all would have been sweetness and light.

It has been argued, for example, that much of the heat could have been taken out of the Darwinian debates if only the Christian doctrine of creation had been properly formulated. That doctrine, it is said, refers to the ultimate dependence of everything that exists on a Creator. It need not entail the separate creation of every species.

Some twentieth-century theologians, notably Rudolph Bultmann, have gone so far as to say that the doctrine of creation has nothing to do with the physical world. Its correct application is to the creation within men and women of an authentic stance toward their earthly predicament. By such means the spheres of science and religion are insulated one from the other.

A third view, which can also be overstated, expresses a more intimate relationship between scientific and religious concerns. Contrary to the first – the conflict model – it is asserted that certain religious beliefs may be conducive to scientific activity. And contrary to the second – the separationist position – it is argued that interaction between religion and science, far from being detrimental, can work to the advantage of both. This more open position clearly appealed to Whitehead, for he raised the question whether the assumption of seventeenth-century natural philosophers, that there was an order imposed on nature, might not have been an unconscious derivative of medieval theology. And he also argued that interaction between religion and science could purge the former of superfluous and obsolete imagery. Once again, the appeal to history is essential to the enterprise. The thesis of the American sociologist, R. K. Merton, that puritan values assisted the expansion of science in seventeenth-century England, would be a good example of historical scholarship in which the mutual relevance of science and religion is affirmed, rather than constant conflict or complete separation.

There are, of course, many variants of these positions. But in their presentation it is almost always assumed that there are lessons to be learned from history. The object of

this book is not to deny that assumption but to show that the lessons are far from simple. The chapters that follow do not pretend to tell a complete or definitive story. They should be read as a historically based commentary rather than as a conventional historical narrative. The principal aim is to assist in the creation of critical perspectives, not to describe a continuous series of seemingly decisive transformations.

Serious scholarship in the history of science has revealed so extraordinarily rich and complex a relationship between science and religion in the past that general theses are difficult to sustain. The real lesson turns out to be the complexity. Members of the Christian churches have not all been obscurantists; many scientists of stature have professed a religious faith, even if their theology was sometimes suspect. Conflicts allegedly between science and religion may turn out to be between rival scientific interests, or conversely between rival theological factions. Issues of political power, social prestige, and intellectual authority have repeatedly been at stake. And the histories written by protagonists have reflected their own preoccupations. In his efforts to boost the profile of a rapidly professionalizing scientific community, at the expense of the cultural and educational leadership of the clergy, Darwin's champion, T. H. Huxley, found a conflict model congenial. Extinguished theologians, he declared, lie about the cradle of every science as the strangled snakes beside that of Hercules.

The purpose of this book is not to recover the corpses. It is to display the diversity, the subtlety, and ingenuity of the methods employed, both by apologists for science and for religion, as they have wrestled with fundamental

questions concerning their relationship with nature and with God. Such is the richness of the subject that it is well to set aside one's preconceptions. There are surprises in store. The same Franklin who devised the lightning conductor was not ashamed to say that, as for the nature of electricity, he was still in the dark. He *was* ashamed about the confidence with which he had earlier thought the subject mastered. As he reflected on the succession of his theories, he observed that one use of electricity had been to make a vain man humble. Franklin had recognized, as Francis Bacon had before him, a congruence between the virtue of humility and the demands of an experimental method. He had recognized that the majestic towers of scientific theory could crumble as spectacularly as the towers of great cathedrals.

It is just such a succession of incompletely successful theories that the history of science reveals, the survivors having some advantage over their predecessors, but rarely in a manner that made evaluation at their inception a straightforward matter. The popular antithesis between science, conceived as a body of unassailable facts, and religion, conceived as a set of unverifiable beliefs, is assuredly simplistic. Theoretical innovations have usually been controversial, often divisive, within scientific communities. Consequently, when they have impinged on the sacred, there has usually been considerable room for debate. To portray the relations between science and religion as a continuous retreat of theological dogma before a cumulative and infallible science is to overlook the fine structure of scientific controversy, in which religious interests certainly intruded, but often in subtle rather than overtly obstructive ways.

An obvious difficulty arises at this stage. How can one speak about the relationship between science and religion, either as practices or as systems of belief, without first defining terms? It is possible to go only so far in meeting this objection. *Religion* has been defined in terms of belief in supernatural beings or in terms of a commitment to some transcendent "other," which serves to integrate one's life. It may refer to organized institutions that, through creed and ritual, claim to give coherent answers to questions of human destiny. Or it may simply refer to any deeply held convictions that find expression in moral imperatives. Although there is often overlap between such definitions, there need not be. In some of the world's religions, Buddhism for example, belief in a transcendent Creator is not affirmed. Because this book is concerned with the relationship between science and religion in the West, most of the contexts in which the word religion is used will be those in which some variant or some critique of the Christian faith was at stake. Too restrictive a definition can, however, be counterproductive because it may exclude too many questions before they have been asked. If the study of history is to be instructive, it is important not to establish foregone conclusions through the rigidity of definitions.

The same difficulty arises with the word *science*. There have been so many definitions offered by philosophers, and by scientists themselves, that it would require another book to consider them. Many refer to some unique "scientific method" to which exemplary science is supposed to conform. But, as the Cambridge philosopher William Whewell observed, almost a hundred fifty years ago, the *history* of science already showed that each new

branch of scientific inquiry had required its own distinctive methodology. And that very process of increasing differentiation reflected a more fundamental change in the meaning of science – from when it had referred to all knowledge and when theology was "queen of the sciences," to its more modern connotations of empirical investigation and high specialization.

There are at least three reasons why the historian might recoil from the demand that "science" and "religion" be rigorously defined before the exercise may begin. The first can be illustrated by a celebrated remark of Isaac Newton. His most famous book, in which planetary orbits were explained by his gravitational theory, was entitled *Mathematical principles of natural philosophy* (1687). It was not entitled *Mathematical principles of natural science*. When seventeenth-century students of nature called themselves natural philosophers, they were identifying themselves with intellectual traditions in which broader issues than immediate scientific technicalities were discussed. Newton himself remarked that it was part of the business of natural philosophy to discuss such questions as the attributes of God and His relationship to the physical world. Very few physicists today would conceive their role in such terms. The point is that if we prejudge what we mean by science and religion, we might be in no position to appreciate the distinctiveness of Newton's vision. There would be a degree of artificiality in asking how Newton reconciled his "science" and his "religion," if he saw himself pursuing a form of "natural philosophy," in which the two interests were integrated.

The second reason for resisting definitions that might prove too constrictive can also be illustrated from the

late seventeenth century when Thomas Burnet wrote his *Sacred theory of the earth* (1684). In it he assumed the role of a Christian apologist, using a knowledge of history to identify certain mistakes that should not be made when theologizing about nature. Thus he applauded St. Augustine for his warning that science and religion should not be too tightly interlocked, that it was dangerous to invoke the authority of Scripture in disputes about the natural world. The danger as Burnet saw it was this: As scientific understanding advanced, propositions that Scripture had been made to affirm would be proved false. Its authority would then be jeopardized on far more important matters. But, says Burnet with evident condescension, Augustine had fallen into the very trap he had identified. He had used the Bible in his dismissal of inhabitants at the Antipodes. Burnet, so much wiser in the late seventeenth century, is even more aware of the danger and knows how to avoid it.

And yet, anyone reading Burnet's *Sacred theory* today would be struck by the fact that he falls headlong into the selfsame trap. Instead of keeping the spheres of science and the Bible apart, he brings them together. He offers a mechanistic account of how the Genesis flood had come about, and he defines the main epochs of earth history with reference to information gleaned from his Bible. His picture of a submerged earth, in which Noah's ark is conspicuous, shows how the flood was made constitutive of the earth's physical history. The point of the example is not to score points against Burnet but to raise the more sympathetic question: How was it possible for Augustine to behave in a manner that, to a later generation, looked inconsistent? And similarly for Burnet. Part of the answer

is that the domains of science and religion were separated by different boundaries in Augustine's day from those in Burnet's day, and in Burnet's day from our own. Precisely because the boundaries have shifted with time, it would be artificial to ask about the relationship between "science" and "religion" as if modern definitions of their provenance had some timeless validity.

A third reason for tolerance on matters of definition is that it can be artificial in a quite different sense to ask about the relationship between science and religion in the past. Because both are rooted in human concerns and human endeavor, it would be a profound mistake to treat them as if they were entities in themselves – as if they could be completely abstracted from the social contexts in which those concerns and endeavors took their distinctive forms. To understand the predicament of Galileo in his relations with the Roman Catholic Church, it is not enough to say that science was in conflict with religion. The political ramifications of the Counter-Reformation were such that Galileo's science (which was not self-evidently correct) acquired meanings and implications that it might otherwise not have carried. The metaphor of a changing boundary or interface is itself too superficial to cope with this particular problem. The way in which the relationship between scientific and religious claims has been perceived in the past has depended on social and political circumstances that the historian cannot ignore. The evolutionary speculations of Charles Darwin's grandfather, Erasmus Darwin, occasioned little hostility in England during the 1780s. But in the conservative backlash, following the French Revolution, they were noisily condemned as atheistic.

FIGURE INT.2. Frontispiece from Thomas Burnet's *Theory of the earth* (1684). Burnet identified seven phases in the earth's physical history. In clockwise sequence, the chaos of the primeval earth as described in Genesis 1 was followed by the smooth-surfaced globe corresponding to a state of paradise. In this second phase the earth's axis of rotation was still vertical, with the consequence that the Garden of Eden, occupying a middle latitude in the Southern Hemisphere, enjoyed a perpetual spring – until the third phase, that of Noah's flood, when the earth's crust collapsed and its axis tilted. The fourth phase is represented and depicted by the earth's current surface. Following a global conflagration, there is the promise of a new heaven and a new earth, with paradise restored before the final consummation. Reproduced by permission of the Syndics of Cambridge University Library.

https://doi.org/10.1017/CBO9781107589018.001 Published online by Cambridge University Press

The existence of a political dimension to many of the debates in which scientific and religious interests were involved means that to abstract both the "science" and the "religion" and then try to establish their mutual relationship can be highly artificial. Indeed, it is tempting to say that we should be more concerned with the use to which scientific and religious ideas have been put in different societies than with some notional relationship between them. Satisfying that concern would require a larger and more detailed book than this is designed to be. But it is important to appreciate that scientific conclusions, however provisional, have often been used by religious apologists in pursuing their own designs. The pressures to protect their authority have sometimes been felt so keenly that they have appropriated the latest science to demonstrate the vitality of their position. In some cases they have run into more trouble by adopting scientific innovations than if they had opposed them.

The fact that science has been used as a resource both by Christians and their critics may call into question another common assumption – that modern science has been largely responsible for the secularization of society. Have the sciences not progressively diminished that sense of awe and mystery that once induced deference to the gods? It is an argument with a long history and a fine pedigree. But it has not passed unchallenged. Critics point out that it may be an unquestioned survival from nineteenth-century positivism when a sense of liberation through science was at its height. They add that it mistakenly assumes religion to depend more on the physical environment than on the quality of social relations. And it

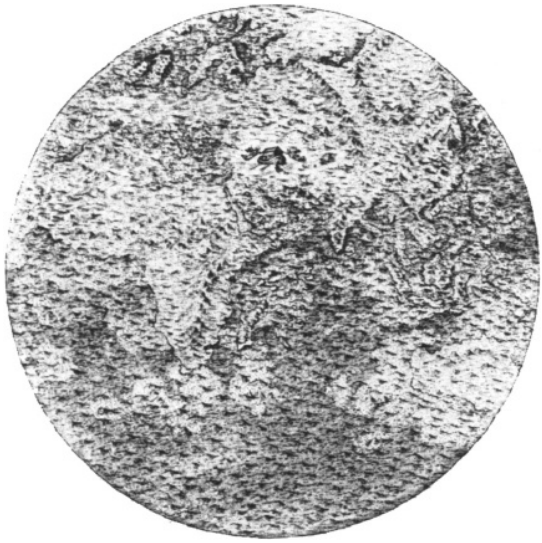

FIGURE INT.3. Illustration from page 101 of Thomas Burnet's *Theory of the earth* (1684). According to Burnet, the deluge had covered the whole of the earth, though he discounted the divine creation of new water. There had been a subterranean aquatic layer concentric with the earth's original crust. The floodwaters had been released when the crust had cracked. The synchronization of these physical events with a crisis in the moral history of humanity, as recounted in Genesis, was, for Burnet, a powerful argument for divine providence. Reproduced by permission of the Syndics of Cambridge University Library.

ignores those respects in which scientific knowledge may magnify rather than diminish a sense of awe. The place of science in the process of secularization may also require reevaluation in the light of religious resurgence in polities where science-based technologies are not conspicuous by their absence. In the pages that follow, we shall try to keep an open mind on issues of this kind.

In Chapter I we consider a series of examples in which statements about God and statements about nature are closely interrelated. They are designed to show how theological and scientific concerns have been mutually relevant in the past. Because statements of an ostensibly religious character fulfilled many different roles in the context of interpreting nature, these examples help to establish the richness and diversity of the interaction. But precisely because they show religious beliefs functioning, as it were, *within* science, they also illustrate the artificiality of discussing the relationship between science and religion as if the province of each had already been established. The implications of these examples for the "conflict thesis" will then be assessed, for they exclude the reductionist view that representatives of science and representatives of the churches have invariably been locked in battle. In seeking to attain what in matters of this kind is ultimately unattainable – a balanced view – it is also necessary to consider whether revisionist histories, structured around a critique of the conflict thesis, have not gone too far in the opposite direction. The apologetic intentions of both secularists and religious thinkers have so colored the literature that a fresh approach is required.

In Chapter II we address a specific historical problem: The interpretation of those shifts in the understanding of nature that, during the sixteenth and seventeenth centuries, added up to what has traditionally been called the Scientific Revolution. A common view is that by the end of the seventeenth century, a recognizably *modern* science had emerged, separated at last from a preoccupation

with matters of philosophy and religion. The object of the chapter is to identify the difficulties that arise in sustaining that view. While it is true that investigations into nature were often subordinate to religious concerns in the late medieval period, it would be misleading to imply that they were bound together in an indissoluble complex until they were prized apart in the seventeenth century. It is also argued that, although there were certain levels on which the problems of science and those of theology were increasingly differentiated during the seventeenth century, the assertion of an absolute separation would be too extreme. Scientific innovations continued to be presented in theological terms and divine attributes continued to be given physical meanings – as when Newton insisted that space was constituted by God's omnipresence.

In Chapter III we raise the question whether parallels can be drawn between the reform of learning through experimental science and the reform of religion that occurred through the Protestant Reformation. The reaction to the sun-centered cosmos of Copernicus provides an appropriate case study because opposition to Galileo, its most famous popularizer, has symbolized the suppression of scientific freedom by the Roman Catholic Church. In taking the Copernican innovation as a test case, however, it soon becomes clear that complications arise when assessing receptivity to new hypotheses. While there is circumstantial evidence to suggest that certain Protestant societies were more tolerant toward new scientific learning, the difficulties that arise in testing such generalizations can be formidable. Just how formidable will be shown in the context of evaluating Merton's thesis that puritan

values were propitious for science in seventeenth-century England.

The theme of Chapter IV is the mechanization of the natural world – that seventeenth-century development which has often been seen as a decisive advance on organic models of the cosmos. The reconstruction of nature through mechanical metaphors has also been seen as a crucial step in the secularization of knowledge; for, if nature ran like clockwork, what room was there for God's direct activity or special providence? Once again, the issues turn out to be far more subtle than that simple question suggests. In the case of Robert Boyle, mechanical images of nature were enlisted in the defense of Christianity. Not only did they reinforce the view that nature was a designed system; they could also be used to emphasize God's absolute sovereignty. If physical phenomena were to be explained exclusively in terms of matter and motion, and if, as both Boyle and Newton insisted, matter itself was inert, then God could be made directly responsible for the motion. But the clockwork image could be read in other ways. One of the many ironies in our story is that a model for the universe, which in the seventeenth century was used to affirm God's sovereignty, was used by the deists of the eighteenth century in their attacks on established religion.

Chapter V takes us into the eighteenth century and into that period of "Enlightenment" when the sciences were hailed as instruments of progress and when institutionalized religion, especially in Catholic countries, was vilified for its superstition and priestcraft. In an age when unprecedented confidence was placed in the power of

human reason, the methods and achievements of the sciences were a powerful resource for those who, with a variety of motives, launched their assault on established Christianity. But to reduce the relations between science and religion to a polarity between reason and superstition is inadmissible, even for that period when it had such rhetorical force. It was often not the natural philosophers themselves, but thinkers with a social or political ax to grind, who transformed the sciences into a secularizing force. Although certain scientific discoveries could be invoked to support a materialist philosophy, they were usually susceptible to less radical interpretations. And in the confrontation between skepticism and Christianity, science could still be on the side of the angels – especially in England where arguments for design retained a strategic role in the defense of the faith. Whereas in France, the materialist La Mettrie would claim that the study of nature made only unbelievers, the contrary claim of Robert Boyle, that one could only be an atheist if one had *not* studied nature, was the more common sentiment in the English-speaking world.

The diverse functions of natural theology, including its role in the popularization of science, is the subject of Chapter VI. The claim that from scientific study one could learn something about God falls strangely on twentieth-century ears. It was, however, a commonplace in the writing of British scientists until the generation that saw the publication of Darwin's *Origin of species* (1859). The object of the chapter is to uncover some of the reasons why this integration of science and religion proved so viable, despite the existence of trenchant critiques. We shall also

consider the extent to which a commitment to natural theology affected the scientific enterprise and the extent to which advances in science affected the plausibility of arguments from design.

For much of the eighteenth century it had been commonly assumed that human history and the history of the earth were coextensive. But during the late eighteenth and early nineteenth centuries, new visions of earth history emerged, presenting a challenge to popular religious belief. As evolutionary models came to the fore in astronomy, geology, and biology, traditional beliefs about humanity's place in nature were increasingly difficult to defend. The emergence of these historical sciences, culminating in Darwin's theory of evolution, is the subject of Chapter VII. The assumptions made in reconstructing the past were often highly controversial even among naturalists themselves. We shall therefore stress the competition between rival scenarios, in which political and religious preferences sometimes constituted a hidden agenda. Although there were countless attempts to harmonize these disturbing vistas with biblical texts, they were eventually abandoned – at least among academic theologians – as the methods of historical research were brought to bear on questions of biblical authorship.

In Chapter VIII we try to take as broad a view as possible of the Darwinian challenge to popular Christianity, in the knowledge that there are circles in which the issues are far from dead. To focus on the post-Darwinian debates is not to deny that the physical sciences also raised new and exciting issues. During the nineteenth century the science of thermodynamics, for example, created new

vistas for the ultimate fate of the universe. The emergence of statistical models in explaining the behavior of gases reopened questions about the nature of scientific "laws." But few would dispute that the impact of evolutionary theory had the more penetrating and enduring effects. We shall therefore survey the many uses to which the Darwinian theory (and corruptions of it) were put. Because the popularization of evolutionary science was so intimately associated with the promotion of social and political ideologies, this chapter provides the most telling illustration of the point made earlier – that it can be highly artificial to abstract the science and the religion from the ensuing debates with a view to determining their mutual bearing. We shall, however, examine the capital that secularists could make out of Darwin's theory and the response of religious thinkers who looked for conciliation rather than confrontation.

In the pluralistic and largely secular societies of the West, a preoccupation with the demands of traditional religion has given way to a humanism that has been described as *beyond* atheism. In helping twentieth-century humanists to rationalize their unbelief, few thinkers have been as influential as Freud, whose attitude toward belief in God is the starting point for a concluding postscript. Despite a prevailing ethos, in which science and secularization are seen as linked together in the constitution of modern culture, the twentieth century has witnessed certain developments in the sciences that have given solace to the religious apologist. Innovations in subatomic physics have been seen as a license for more organic and less deterministic models of reality. Moreover, new scientific techniques have raised ethical questions of such gravity

that the general public has become aware of an interface along which science and human values meet. As long as the world's religions continue to stake a claim in the articulation of those values, it is unlikely that the two spheres of science and religion will be completely divorced.