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2 Religion and the Scientific Revolution

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The Scientific Revolution has always played a prominent part in the historiography of science and religion. Historians typically use the expression 'Scientific Revolution' to refer to that period from the early sixteenth century to the late seventeenth, when something recognizably like modern science coalesced out of previously distinct traditions such as natural philosophy, the mathematical sciences and Renaissance magic.¹ The importance of this period in science and religion discussions is largely owing to the *causes célèbres* provided by the Copernican theory in general (which defied the biblical pronouncement that the earth shall not be moved²), and by Galileo's championing of the theory in particular. Second only to Darwinism, the Copernican revolution and the Galileo affair are all too often regarded as demonstrating clearly and irrefutably that science and religion just do not mix, and indeed are essentially incompatible with one another. But this view only came to be accepted in the late nineteenth century when science became, not a weapon to be used against religion, but a battlefield, over which both religionists and secularists fought.³ For the vast majority of us today religious belief is a matter of personal choice, but before secularism became the norm in the West God and religion were so pervasive in social, political and intellectual life that it seems fair to say that all but a very few intuitively thought in a religious way. It was as inevitable as anything can be in history, therefore, that those concerned with studying and understanding the natural world in the early modern period were every bit as religious as the population at large. Certainly, it is true to say that virtually all of the most prominent figures in the historiography of the Scientific Revolution were religiously devout, and some of them extremely so.⁴

RELIGIOUS INSTITUTIONS AND SCIENCE

Recent research on the so-called Galileo affair has shown that it involved such a unique set of circumstances that it cannot be used to establish a

general incompatibility between science and religion. After all, Galileo was given permission by Pope Urban VIII (1568–1644) to write his *Dialogue on the Two Chief World Systems* (1632). Given that this was after his predecessor as Pope had issued a ruling in 1616 against the Copernican theory, it showed that the Papacy could be flexible on the matter. Furthermore, the main issue at the trial was not so much that Galileo had defended the Copernican theory, but that he had done so after being ordered at the earlier ruling of Pope Paul V (1550–1621) not to hold, defend or teach it ‘in any way whatever’, and that by neglecting to mention this when asking for permission to write the *Dialogue*, he had deceived Urban VIII (although Galileo had legitimate grounds for denying the validity of the stringent 1616 order against him).⁵

There can be no denying that the churches, as formal institutions, were regularly mobilized against thinkers whose writings were deemed to be potentially threatening to the church and its authority. But generally speaking, natural philosophers, astronomers and others concerned with the nature of the physical world attracted far less attention than theologians did. Cardinal Roberto Bellarmino (1542–1621), a leading member of the Holy Office under Paul V, when the church made its ruling against the Copernican theory, had so displeased an earlier Pope, Sixtus V (1521–90), that one of his own books almost ended up on the Index of Prohibited Books, and of course, a number of printed editions of the Bible were proscribed on the Index.⁶ Nobody has ever argued that this proves religion per se is unsustainable against itself; it simply makes it obvious that complex institutions, widely interconnected with other social and political institutions, must respond to many pressures, and try to anticipate a bewildering range of possible developments which might result from innovation. It is hardly surprising, therefore, that the churches sometimes acted against innovations in the sciences and in philosophy; but this should not be taken to mean that religious belief and the scientific enterprise are inherently inimical to one another.

The major example, after Galileo’s, of the works of a leading innovator being prohibited is provided by René Descartes (1596–1650). The Cartesian system was proscribed by the French crown and subsequently the Holy Office, not only because of its perceived scepticism, but also because it undermined the traditional Aristotelian explanation of how transubstantiation – the official doctrine regarding transformation of the substances of bread and wine into the body and blood of Christ during the Eucharist – could occur without anyone being able to taste anything but bread and wine.⁷ But long before this, the earliest would-be reformers of natural philosophy, seeking to replace Aristotelianism with their

own superior systems, Girolamo Cardano (1501–76), Francesco Patrizi (1529–97), Giordano Bruno (1548–1600) and Tommaso Campanella (1568–1638), were all at some point in their careers imprisoned by the Inquisition.

This kind of policing of innovatory natural philosophy was usually conducted by the Roman Church, which had administrative apparatus for dealing with such matters, but there is evidence that the Reformed Churches might have followed suit if they had had a similar administration. Michael Servetus (1509/11–53) was burnt at the stake in Geneva, under the auspices of Jean Calvin (1509–64). Primarily a medical writer, Servetus is usually credited with being the first to realize that blood travelled from the right ventricle of the heart to the left, not by passing through the flesh of the heart between the two ventricles (as was believed), but by passing through the lungs. We now know the purpose of this is to aerate the blood, but for Servetus it was to enable the blood to take up the Holy Spirit, which he held to be all around us in the air that we breathe. This was too materialistic a notion of the Holy Spirit for Calvin to countenance and Servetus was executed by the Reformed Church for, among other things, denying the Holy Trinity.⁸ Cartesianism could not be proscribed throughout the federation of states in the Netherlands, as it was in absolutist France, but it certainly encountered official opposition in Utrecht and Leiden, where powerful professors of theology swayed the city councils into ruling against it.⁹

NATURAL PHILOSOPHERS AS THEOLOGIANS

Whatever the tensions between religious institutions and science, it is a matter of historical fact that many, if not all, of the leading natural philosophers of the Scientific Revolution were devout believers. Furthermore, they did not simply maintain a routine faith as they pursued their interests in studying the natural world; many of the leading thinkers in the Scientific Revolution clearly recognized a need to turn themselves into what we might call amateur theologians and to develop their own theological positions alongside their new natural philosophies. The result was, as Amos Funkenstein has pointed out, that for a short time (throughout the period of the Scientific Revolution) ‘science, philosophy, and theology [could be] seen as one and the same occupation’.¹⁰ It is important to note that this entailed, as Funkenstein says, ‘a new and unique approach to matters divine, a secular theology of sorts’, because, apart from anything else, theology had been a protected

profession since the thirteenth century – protected, that is, from the incursions of laymen. Furthermore, although natural philosophers prior to this had occasionally found themselves encroaching on theological matters, for the most part they avoided such areas, and they always deferred to the theologians.

Certainly, the natural philosopher was exclusively concerned to explain natural phenomena in naturalistic terms. It would have been considered a betrayal of the precepts of natural philosophy, for example, simply to invoke God as the explanation for a physical effect or process. God was always recognized as the first (or primary) cause, without whom nothing would be as it is; but the natural philosopher was concerned to understand phenomena in terms of the secondary causes through which it was assumed that God always chose to operate. This assumption was conceded by the theologians, and was considered by them to provide the *raison d'être* for natural philosophy. The only possible exceptions to this assumption were miracles, but these required careful handling by theologian and natural philosopher alike, because the claim that God intervened directly to accomplish the miracle seemed to imply lack of foresight on God's part, while the claim that he achieved the miracle by secondary causes seemed to suggest, however unusual the secondary causation was (such as a passing comet, for example), that it might not have been a miracle at all.¹¹

It is misleading, therefore, to suppose, as one recent commentator has, that natural philosophy was fundamentally 'an enterprise which was about God', in contrast to modern science wherein God's 'existence and attributes are taken to be *irrelevant*'.¹² For the most part, God's existence and attributes were (although taken for granted) assumed to be irrelevant to the naturalistic aims and achievements of medieval natural philosophy.¹³ Accordingly, as Funkenstein says, the secular theology developed by the so-called new philosophers of the early modern period was not only 'new and unique', but also 'of fundamental social and cultural importance'.¹⁴ Its profound importance has been demonstrated in recent scholarship which has shown that developments in the Scientific Revolution can be properly understood only against the backdrop of the theology which inspired and supported them.

One of the most important, and most recent, contributions to this scholarship, for example, has seen the new amalgamation of theology and natural philosophy in the early modern period as foundational in establishing the scientific culture of the West today. Natural philosophy was reshaped so that 'What we find with growing momentum as the seventeenth century progresses, are repeated and increasingly

successful attempts to ally natural philosophy with revelation in an attempt to share an entirely new cultural role for natural philosophy.' Stephen Gaukroger, the author of this view, like Funkenstein, believes that 'Christianity set the agenda for natural philosophy,' and played the most crucial role in the subsequent cultural success of science.¹⁵

Before considering the major kinds of theologizing which have been discerned in the rise of modern science, it is worth asking why theology made this sudden encroachment into natural philosophy after centuries of separation. Essentially, the answer lies in the medieval handmaiden tradition discussed in the previous chapter. The pervasiveness of this tradition ensured that early modern natural philosophers were concerned to show how their new philosophies, in spite of their unfamiliarity, continued to serve theology. This was especially important, of course, when there was more than one version of Christianity seeking support. Natural philosophers from different confessional or denominational backgrounds began to insist that their natural philosophy supported their particular brand of religion better than any other. Francesco Patrizi suggested that his Neoplatonic system of philosophy should replace Aristotelianism in the schools because it was more in keeping with Catholic doctrine and would bring erring Protestants back to Holy Mother Church; Paracelsian medical theories were used by radical sectarians to support their religious views; and the work of the Royal Society, one of the first scientific institutions, was said by its first founders to be based on the method for establishing truth first developed by the Church of England.¹⁶

The urgency of showing how a new natural philosophy could be used to support the faith also arose from the pervasive perception that atheism was beginning to flourish, and what was worse, that for many outside the ranks of natural philosophy, the new philosophies were regarded as instrumental in helping to spread atheism. The actual prevalence of atheism at this time is impossible to ascertain (it was perforce a very clandestine position), but what is undeniable is that it was widely perceived to be a constant threat to religion and to society. Its evident emergence in Christendom in the sixteenth century is commemorated by the fact that the word atheism was coined at that time (previously there had been only heresy). Any attempt to assess the real history of atheism is clouded by the fact that charges of atheism, like charges of witchcraft, were levelled at those who merely subscribed to a different creed, but the early modern fear of atheism was undeniable.¹⁷

There were good reasons, as far as the orthodox were concerned, for implicating the new philosophies in the promotion of atheism. For

example, the dominant matter theory of the new philosophies developed by Descartes, Pierre Gassendi (1592–1655), Thomas Hobbes (1588–1679), Robert Boyle (1627–91) and others was essentially atomistic, which was the matter theory favoured by the newly rediscovered ancient atheists (supposedly), Epicurus (c.341–270 BC) and Lucretius (c.99–55 BC).¹⁸ Gassendi was assiduous in his apologetic efforts on behalf of Epicurus. Boyle was apologetic on behalf of Descartes, Gassendi, and atomism in general. Others, however, demonstrated the religious credentials of their own philosophies by showing the dangers inherent in rival philosophies of nature, thereby promoting, as they tried to dissipate, the view that new philosophies tended to undermine sound religion. Henry More (1614–87), who introduced Cartesianism into Cambridge University, later saw it as perniciously irreligious, while for Isaac Newton (1642–1727) Descartes' philosophy seemed to be 'made on purpose to be the foundations of infidelity'.¹⁹

A GENERAL THEORY OF RELIGION AND THE RISE OF SCIENCE: PROTESTANTISM AND SCIENCE

One of the earliest suggestions that there might actually be a positive connection between religion and scientific achievement grew out of the observation by the Swiss naturalist Alphonse de Candolle (1806–93) in 1873 that Protestants seemed significantly to outnumber Catholics among the ranks of European scientists, even though Catholics vastly outnumbered Protestants in the general population. When the historian Dorothy Stimson tentatively suggested in 1935 that Puritanism was an important factor 'in making conditions in England favourable to the new philosophy', she offered no analysis as to why this might be so but relied on the claim that the majority of contributors to the scientific movement in seventeenth-century England seemed also to belong to the Puritan movement.²⁰ It was at this point that the sociologist Robert K. Merton proposed what came to be called the Puritanism and science thesis (1938). Merton, it has to be said, relied to a large extent on the same kind of head-counting to make the case that there must be a link between Puritanism and science. The trouble with this kind of evidence, however, is that it is endlessly open to dispute. No consensus has ever been reached as to how to determine who counts as a Puritan and who does not.²¹

Merton did, however, try to strengthen his argument by offering a theoretical explanation as to why Puritanism should have been

particularly conducive to innovation in science. His explanation drew on the claims of the German historian and sociologist Max Weber (1864–1920), laid out in his *Protestant Ethic and the Spirit of Capitalism*, particularly Weber's characterization of the Protestant ethos in terms of a 'this worldly' asceticism and the notion that one can have a vocation not just to the spiritual life, but also to a secular occupation or career.²² Unfortunately, much of Merton's argumentation was vague and ultimately unpersuasive: the experimental method, he tells us, 'was the scientific expression of the practical, active, and methodological bent of the Puritans'.²³ Even so, although always controversial among historians, the Merton thesis has never quite gone away, and it is hard, therefore, to resist the conclusion that there must be something in it.²⁴

Arguably the strongest historical case for the links between Puritanism and science has been made by Charles Webster. He drew attention to the millenarianism of the period and showed that this aspect of Puritan theology played a crucial role in the promotion of scientific and technological innovation. The millennium was to be a thousand-year period of prosperity and happiness on earth, a return perhaps to the way things were in the Garden of Eden. Whether this was to take place after the Second Coming of Christ or, as some believed, before it, the fact that it was to be lived on earth meant that improvements in earthly life would be required. For the reformist thinkers that Webster discusses, it was the duty of the faithful to try to usher in the required improvements as soon as possible, and to contribute as much as possible to the amelioration of life on earth, in readiness for the consummation of these improvements during the millennium. In so doing, these reformers were taking their lead from Francis Bacon (1561–1626), who was convinced that the time was at hand when man's dominion over creation, lost at the Fall, could be restored by carefully organized and well-directed labour.²⁵ The Baconian Great Instauration, or restoration of the true philosophy of nature, was attempted, according to Webster, by Puritan reformers seeking to prepare for the millennium.

This is persuasive, but there remains one problem from the perspective of our attempts to assess the relations between science and religion. Webster's historical protagonists are concerned with a range of pragmatic concerns, including agriculture and animal husbandry, which do not always coincide with our notion of science. If our aim is to discover the role of religion in the origins of modern science, it is something of a distraction to look at the kinds of enterprises being pursued by Webster's group of reformers.²⁶

Perhaps the problem is that we have moved away from Protestantism to Puritanism, and what is more to Puritanism in England. There have been a number of attempts to refine Merton's thesis by focusing on other religious groups in England, including orthodox Anglicans who turn to science as a pious pastime throughout the civil war period, when their religion is proscribed; and so-called Latitudinarian Anglicans, whose irenic doctrinal minimalism coupled with a liberal scepticism has been seen as going hand-in-hand with a Baconian emphasis upon gathering facts without interpretation, and cautious empiricism without theorizing.²⁷ There is something to be said for these alternatives, but their concern, like Stimson's, Merton's and Webster's, is only with the situation in England. There is certainly more to be said on the broader issue of Protestantism, as a European phenomenon, and science.

The unexpectedly high proportion of Protestant scientists in predominantly Catholic Europe can in part be explained by various piecemeal factors. The widely known condemnation of Galileo in 1633 perhaps made it harder for Catholic thinkers to accept Copernicanism. Doctrines of the Eucharist must have made it harder for devout Catholics to accept the new quasi-atomist matter theories which were dominant in the new philosophies (this would also have tended to discourage Lutherans from embracing the new science, but would not have affected Calvinists).²⁸ Perhaps these things in turn meant that Catholic natural philosophers had a greater tendency to retreat into a kind of fideism when their philosophies seemed to run counter to the doctrines of their church. Certainly, of the three famous cases of early modern natural philosophers who abandoned their secular interests in favour of a retrenched piety, two were Roman Catholics: Niels Stensen (1638–86), a convert from Lutheranism, and of course, Blaise Pascal (1623–62); and the third, Jan Swammerdam (1637–80), came under the spell of the Flemish Catholic mystic Antoinette Bourignon (1616–80).

There is, however, a much more general theory, proposed by Peter Harrison, which offers a highly plausible account of why Protestants were more pioneering in science than Catholics. The notion that God is the author of two books – the book of Scripture, and the book of nature – has a long history, but the reading of the book of Scripture underwent a dramatic change from the outset of the Reformation. Rejecting the mediation of a corrupt priesthood, the Protestants urged the faithful to read the Bible for themselves. Still forbidden to lay Catholics, the Bible began to be read by the rank and file among Protestants – and vernacular translations were rapidly made available from the printing presses. Harrison's claim, put simply, is that ensuing dramatic changes in the

reading of Scripture carried over in significant ways into the reading of God's other book. The more literalist reading of the Bible favoured by the Protestants led readers of the book of nature to develop a more naturalistic reading. Rather than embellishing what they saw in nature, and investing it with allegorical or other kinds of extra significance, they noted only what could be seen, and took a down-to-earth and cautious attitude to interpreting its meaning. 'The modern approach to texts, driven by the agenda of the reformers and disseminated through Protestant religious practices,' Harrison suggests, 'created the conditions which made possible the emergence of modern science.'²⁹ This important realization has also been taken up by Stephen Gaukroger in his major synthesis of the role of religion in the formation of our predominantly scientific culture. 'The combination of revelation and natural philosophy – the two books superposed into a single volume, as it were – produced a unique kind of enterprise,' Gaukroger proposes, 'and one that was largely responsible for the subsequent uniqueness of the development of natural philosophy in the West.'³⁰

VOLUNTARIST AND INTELLECTUALIST THEOLOGIES AND EMPIRICISM VERSUS RATIONALISM

Other theories of the relationship between religion and science have focused on particular theological positions rather than confessional allegiances – although as a matter of historical fact the theological positions can sometimes be seen to be affiliated to particular groups. The first of these positions to be discerned by historians of science, and the most extensively discussed, is what has come to be called voluntarist theology.³¹ Deriving from medieval efforts to define and defend the boundless omnipotence of God, voluntarist theologians insist, among other things, that God was able to create the world in a free and unconstrained way – without having to conform to pre-existing notions of goodness, for example, or predetermined aspects of what matter, say, could be made to do. The creator, or cosmic *demiourgos*, described by Plato (429–347 BC) in his *Timaeus*, forms the world out of the chaos, but there is only so much he can do because matter is recalcitrant and unsuitable for doing everything the creator might desire. In Christian theology, however, God is omnipotent, and creates the matter he requires for the creation. Like Plato, Aristotle (384–322 BC), the supreme authority in medieval philosophy, also had a tendency to declaim what was physically possible and what was not. As was seen

in the previous chapter, this brought Aristotelian natural philosophy into conflict with theology. The response of Etienne Tempier (d. 1279), bishop of Paris in 1277, to the proscribed Aristotelian propositions was effectively a voluntarist stance. Notwithstanding what Aristotle declares to be physically possible, God could, for example, make a void space if he so wished.

Voluntarist theology came to the fore once again when the new philosophers sought to show that their philosophies, far from being atheistic, went hand-in-hand with the notion of an omnipotent God. As well as the ubiquitous threat of atheism, the background to this included a revival of attitudes closer to those of Plato and Aristotle, in which God had to conform in the creation to various truths, moral or physical, which were held to be uncreated and co-eternal with him. This is usually referred to in the literature as intellectualist theology, and broadly speaking its revival was intended not to defend ancient pagan thought, but to reject various strands of Protestant thought which were seen as antinomian in morality and lacking in rational persuasiveness in natural philosophy. With regard to morality, the voluntarist believed that what God decreed to be good was good (by definition), but the intellectualist insisted that God, because of his goodness, could only decree what was good (in absolute terms). The latter position implied that God's creative power was limited by certain constraints, but for intellectualists this was preferable to the antinomianism of supposing that anything, no matter how vicious, might be considered good, if God declared it to be. For voluntarists, however, the intellectualist position arrogantly presumed to be able to know what was best, and to dictate those terms to God. Furthermore, voluntarist antinomianism was bound up with the revived Augustinian notion that salvation could be achieved only by the freely bestowed gift of God's grace – it could not be earned by doing supposedly good works.

Intellectualist theology manifested itself in natural philosophy in attempts to provide supposedly unassailable rational proofs for the existence of God. The Cambridge Platonist, Henry More, for example, based his argument on a supposed categorical distinction between the material and the immaterial. Borrowing from Cartesianism, he insisted that matter was completely passive and inert, and that, accordingly, the activity in the world (including all the motions of bodies) must be brought about by an active principle, which must be immaterial spirit. Having established that immaterial spirit must exist (otherwise the world would have no activity), it is then an easy matter to insist that God must exist, and to refute all would-be atheists.³²

The problem with this for voluntarist thinkers was that the force of the rationalist argument made less impression than the clear implication that God was not as omnipotent as he was usually held to be. The Presbyterian churchman Richard Baxter (1615–91) wanted to know how More could be sure that God could not make matter active. The cynical answer to this question is that More could not allow this because it would completely undermine his efforts to refute atheist materialism, but of course, More argued the point by combining traditional Christian dualism with Cartesian dualism and insisting that matter was by its very nature inert, and not even God could make it active in its own right.³³

Not every intellectualist subscribed to the same set of starting assumptions, but they all ended up relying on a supposedly rationally determined principle which they discerned in the world (analogous to More's principle that matter must be completely inert), and which pointed to the existence of God. For G.W. Leibniz (1646–1716), another leading intellectualist, the existence of God was guaranteed by the complex interconnectedness of everything in creation. He famously took issue, therefore, with Isaac Newton's suggestion that perhaps the motions of the planets were gradually slowing down and that, at some time in the future, to prevent the dissolution of our world system, God would perhaps send a comet to add a gravitational kick to the system and speed the planets up again.³⁴ This was all too sloppy for Leibniz, who objected to the fact that Newton's God was such a poor craftsman that he 'wants to wind up his watch from time to time'.³⁵ The point is that for Leibniz, Newton's God was so inadequate that dissemination of Newton's ideas would undermine religion. For Newton, however, it was important to avoid the Cartesian (and Leibnizian) scenario, in which once God had set the universe running, his presence was no longer required – all could be carried on by bodies operating in accordance with the laws of nature. A world running on its own, with an absentee God, was for Newton and others, to all intents and purposes, an atheistic world picture.

Another important aspect of this rivalry is that it has been seen as shaping the methodology and epistemology of early modern science. Intellectualists are committed to the idea that, just as there are absolute principles of morality which are co-eternal with God, so there are rational principles which dictate the kind of world that God can create. As Voltaire satirized the Leibnizian position, God, in accordance with his own goodness, must create the best of all possible worlds. Since the best world is discoverable by reason, it ought to be possible for the

philosopher to reconstruct God's thinking in the creation, and to arrive at an understanding of the world simply by the use of reason. Voluntarists, by contrast, deny any such ineluctable chain of thinking which guided, or forced, God's hand in the creation. For them, the only way to discover how God created the world is to examine it closely. Only *a posteriori* knowledge of the world is possible. Accordingly, voluntarist theology has been seen as going hand-in-hand with empiricist approaches to an understanding of the world.³⁶ It seems likely, therefore, that voluntarist theology was revived in order to support the empiricist preoccupations of thinkers like Boyle, Newton and others, and conversely, to enable these same empiricists to dismiss the rational approach of their critics not only on the grounds that it may be misconceived, but also on the grounds that it necessarily implies that God is not omnipotent, but is determined to operate in a particular way.³⁷

THE THEOLOGY OF POST-LAPSARIAN ANTHROPOLOGY AND EMPIRICAL SCIENCE

More recently, another theological justification for empiricism has been recognized, namely the belief in the corrupt and deficient state of humankind, in both body and mind, after the Fall. According to this view, forcefully suggested by Peter Harrison, those who favoured the revival of Augustinianism over the Thomism of medieval scholasticism subscribed to assumptions about the post-lapsarian state of humanity which implied the inadequacy of human reasoning powers, and therefore the unreliability of rationalist natural philosophies. Adam had once known all things, was blessed with senses capable of discerning far more than we can, and with a mind which could unerringly interpret what his senses told him and enable him to achieve immediate knowledge of the essence of things. After the Fall, however, Adam and his progeny not only forgot what they once knew, but also the acuity of their senses was diminished, as were the powers of their minds. The scholastics of the Middle Ages had taken the Thomist line that Adam had originally been possessed of both natural and supernatural gifts and that at the Fall he had been deprived only of the supernatural gifts. Reason, according to the Thomist view, was a natural gift and had been unaffected by the Fall (which enabled scholastics to hold the view that, even though Aristotle was a pagan, he could still have a formidable capacity for reasoning).³⁸ This was counter to the Augustinian view, however, which took a much more pessimistic view of our abilities after we all

became inheritors of original sin. The Augustinian view was vigorously revived by the leading reformers, Martin Luther and John Calvin, and embraced by the counter-reforming Catholics, the Jansenists, thereby introducing another important theological element into the mixture of science and religion in the early modern period. The response to this revived Augustinianism, of course, was to reject the Thomist approach which essentially favoured the use of reason, and to develop an empiricist approach, which was in itself rendered even less prone to dogmatic conclusions by scepticism about our ability correctly to interpret observations and other empirical results.³⁹ The emphasis, accordingly, was on painstaking work to slowly gather knowledge, either by observations or by the careful performance of many experiments, but this was accompanied not by assurances that certainty could be reached in this way, but by diffidence as to whether certain knowledge could ever be achieved.

Harrison's thesis is undeniably powerful, not only because it is backed by an impressive array of evidence from writers of the period, who all show a clear concern with the state of man after the Fall and its implications for what we can know, but also because it dovetails very neatly with many other aspects of current historiography. It stands alongside the work of Richard H. Popkin and others, for example, on the growth of scepticism from the Renaissance through the early modern period. Popkin has seen this in terms of a crisis of thought brought about by the dethroning of Aristotle and other ancient authorities, and the realization that scepticism was a popular standpoint among the ancients themselves, but it is possible that a more nuanced re-examination may reveal a theological dimension to this.⁴⁰

Similarly, Harrison's claim goes hand-in-hand with the claims of Charles Webster and others about the importance of millenarian-inspired attempts to recover the lost wisdom of Adam for the development of modern science. While Webster has seen this as a feature of heightened millenarian expectations in the Reformation, chiefly by radical thinkers, Harrison argues that attempts to recover Adamic wisdom were a broader concern of Protestant natural philosophers.⁴¹

Harrison has even gone so far as to suggest that it is a concern with what can be known by fallen man that really lies behind voluntarist theology. Voluntarists reject the rationalism of the intellectualists not because they are concerned about the omnipotence of God, but because their Augustinianism persuades them that reliable rational thinking has not been possible since the expulsion from Eden. There is certainly something in this. There seem to be sufficient overlaps between the

concerns of the supposed voluntarists and the post-lapsarian pessimists who form the focus of Harrison's study that it is impossible completely to separate them. It is worth pointing out, however, that to abandon the separate category of voluntarism would result in a diminishing of our understanding. The omnipotence of God certainly seems to be a pressing concern for those in the debates characterized heretofore as voluntarist versus intellectualist, and it is clear that this concern is bound up with attempts to prove God's existence to supposed atheists. The perceived threat of atheism is hardly likely to be dented by appeals to the inadequacy of our mental capacities based ultimately on what it says in the Bible. Indeed, it could even be argued that the appeal to the inadequacy of mental capacities after the Fall functions at a rhetorical level in the natural philosophical literature, showing the author's acceptance of Augustinian precepts to fellow Protestants, say, while the discussions of what God can and cannot do have a much more direct bearing on the content of their natural philosophies. It seems reasonable to conclude, anyway, that Harrison has exposed a rich part of the background to the development of the experimental method, especially in seventeenth-century England, but that this should be seen alongside the parallel and closely related voluntarist tradition, rather than substituted for it.⁴²

DESCARTES, THEOLOGIAN, AND THE LAWS OF NATURE

It is evident from the depth and detail of theology into which the new philosophers descended that they were not simply paying lip-service to theology in order to avoid charges of impiety. On the contrary, it is evident that they really did see it as an essential aspect of their natural philosophies, often to the extent of underwriting their philosophical claims. A very clear example of this is provided by the first attempt to codify precise laws of nature as the basis for a new system of physics. The notion of laws of nature in a loose and vague sense (it is a law of nature that bees make honey, or that the sun always rises, and so forth) had been current since time immemorial, but Descartes introduced the modern concept of a restricted number of precise laws which could be used to explain or predict a vast array of physical phenomena. In essence, Descartes had to rely upon his laws to enable him to provide explanations of physical events in terms of causes. Causal explanations were the *sine qua non* of Aristotelian physics, but Descartes' new system disallowed explanation in terms of the traditional Aristotelian four causes. Descartes' three laws of nature, therefore, were offered as

replacement explanatory principles in their own right. The second law, for example, 'that all movement is, of itself, along straight lines; and consequently, bodies which are moving in a circle always tend to move away from the centre of the circle', could be used to explain, among other things, why shot whirled in a sling will have a tendency to move away from the centre of rotation while constrained by the sling, but will fly off at a tangent to the rotation when released. These everyday phenomena in turn can then be used to explain, by analogy, the rotations of the planets, the behaviour of light rays, and other phenomena.⁴³

But Descartes is supposed to be a physicist, not a law-maker, and besides, how can inanimate matter know the laws that Descartes has decreed, much less obey them? Descartes knew that he had to answer questions like this even before they were asked. Consequently, he had to introduce God into his physics. The laws were laid down not by Descartes but by God, and the laws were not so much imposed on inanimate matter as self-imposed upon God, who ensured that bodies always acted in accordance with the laws. Descartes' theology emphasized the immutability of God, not only to ensure the perpetuity of God's self-denying ordinance of always conforming to his own laws, but even to explain the second law (things left to themselves move in straight lines because this kind of movement does not require God continually to make new decisions as to which path a body should follow).⁴⁴ Here then we have a clear, and very profound, case of an innovator in natural philosophy introducing a carefully wrought theology into his natural philosophy, not on a whim owing to routine piety, but because he recognized that his physics would be completely unworkable without an immutable God to guarantee it.⁴⁵

Descartes' theology, in its details, is effectively *sui generis*, tailor-made for his own purposes, although it certainly conforms in broad terms to standard Christian theologies. He was by no means the only one engaged on such an enterprise, however. Many of the leading natural philosophers took similar pains to show how their natural philosophies related to religion and theology. Perhaps the most prominent examples would be Johannes Kepler (1571–1630), Robert Boyle, Isaac Newton and G.W. Leibniz. Indeed, in view of the claims made about the importance of theology in early modern natural philosophy by Funkenstein and Gaukroger, we can now see why it is that the leading natural philosophers were the ones who seem in retrospect to be the most devout: they seem the most devout because they expended as much of their intellectual energy on theological matters as on scientific, and in so doing they became, *ipso facto*, the leading natural philosophers.

NATURAL THEOLOGY, DEISM AND BEYOND

Stephen Gaukroger's ambitious synthesis of much of the scholarship on science and religion in the early modern period takes due note of the undeniable importance of religion in the 'emergence of a scientific culture', but its main aim is to show 'the assimilation of all cognitive values to scientific ones and . . . how this came about'.⁴⁶ In short it is a study of the rise of science, and ultimately, this is not a story in which science and religion remain equal partners, strolling hand-in-hand through subsequent ages. The secular theology developed by sixteenth- and seventeenth-century natural philosophers, as Funkenstein points out, emerged 'to a short career'.⁴⁷ Much of the scholarship on science and religion in the early modern period has been concerned with the decline of religion, as science moves into ascendancy. A major aspect of this story is, ironically, the development of so-called natural theology, which is fully discussed in the next chapter. Arguably, the earliest contributions to this particular manifestation of the coming together of science and religion were *The Darknes of atheism dispelled by the light of nature* (1652), by Walter Charleton (1620–1707), and Henry More's *Antidote against atheism* (1653). From these beginnings, natural theology went on from strength to strength. This was particularly true in England where Newtonian natural philosophy came to be used frequently in the annual series of lectures established by the terms of Robert Boyle's will 'for proving the Christian Religion'. Beginning with the series delivered in 1692 by Richard Bentley (1662–1742), the Boyle lectures ran until 1714 and helped to forge what has been seen as a holy alliance between Newtonian natural philosophy and Anglicanism which was characteristic of Enlightenment England.⁴⁸ The emphasis upon the intricacies of Newtonian natural philosophy to prove the existence of God meant that revelation was supplanted by reason, however, and the result was the growth of Deism at the expense of the traditional institutions of the church, and arguably (see John Hedley Brooke's discussion in chapter 5) the beginnings of secularization. For at least one commentator, this has been seen as the ultimate irony in relations between science and religion. R. S. Westfall has argued that the efforts of devout natural philosophers and even leading churchmen to use Newtonian natural philosophy to establish the existence of God, rather than relying on more traditional ways of asserting religious values, led many contemporaries into Deism. In seeking to overcome the threat of atheism, the Anglican Church's emphasis upon natural religion led to a

deistic tendency to deny the validity of revelation and Scripture, and led to an irreversible weakening of the Church of England.⁴⁹

Notes

- 1 J. Henry, *The Scientific Revolution and the Origins of Modern Science* (Basingstoke and New York: Palgrave Macmillan, 2008), pp. 1–11. On science and religion in the period, see, for example, *ibid.*, ch. 6, pp. 85–98; R. Hooykaas, *Religion and the Rise of Modern Science* (Edinburgh: Scottish Academic Press, 1972); A. Funkenstein, *Theology and the Scientific Imagination from the Middle Ages to the Seventeenth Century* (Princeton University Press, 1986).
- 2 The biblical reference is Psalm 96:10.
- 3 See John Hedley Brooke, chapter 5 in this volume, and F.M. Turner, 'The Victorian Conflict between Science and Religion: a Professional Dimension', in F.M. Turner, *Contesting Cultural Authority* (Cambridge University Press, 1993), pp. 171–200.
- 4 The English mathematician and physicist Thomas Harriot (1560–1621) was accused of atheism but the truth of this is by no means certain, and besides, he hardly counts as a prominent figure in the historiography of science; R. Fox (ed.), *Thomas Harriot* (Aldershot: Ashgate, 2000). More prominent is Thomas Hobbes (1588–1679), who was also widely regarded as an atheist by his contemporaries, although from our perspective he looks more like a heterodox believer. Compare S.I. Mintz, *The Hunting of Leviathan* (Cambridge University Press, 1962), with A.P. Martinich, *The Two Gods of Leviathan* (Cambridge University Press, 1992).
- 5 For a detailed account, see A. Fantoli, 'The Disputed Injunction and its Role in Galileo's Trial', in E. McMullin (ed.), *The Church and Galileo* (University of Notre Dame Press, 2005), pp. 117–49. For a brief overview, see W.R. Shea, 'Galileo and the Church', in D.C. Lindberg and R.L. Numbers (eds.), *God and Nature* (Berkeley: University of California Press, 1986), pp. 114–35.
- 6 R. Bellarmino, *Disputationes de Controversiis* (Ingolstadt, 1586); R.J. Blackwell, *Galileo, Bellarmine, and the Bible* (University of Notre Dame Press, 1991).
- 7 N. Jolley, 'The Reception of Descartes' Philosophy', in John Cottingham (ed.), *The Cambridge Companion to Descartes* (Cambridge University Press, 1992), pp. 393–423.
- 8 M. Servetus, *Christianismi restitutio* (Geneva, 1553); J. Friedman, *Michael Servetus* (Geneva: Droz, 1978).
- 9 Jolley, 'The Reception of Descartes' Philosophy', pp. 394–7.
- 10 Funkenstein, *Theology and the Scientific Imagination*, p. 3.
- 11 On miracles, see, for example, P. Harrison, 'Newtonian Science, Miracles, and the Laws of Nature', *Journal of the History of Ideas* 56 (1995), 531–53.

- 12 A. Cunningham, 'Getting the Game Right: Some Plain Words on the Identity and Invention of Science', *Studies in History and Philosophy of Science* 19 (1988), 365–89, p. 384.
- 13 This has been spelt out in response to Cunningham by E. Grant, 'God, Science, and Natural Philosophy in the Late Middle Ages', in Lodi Nauta and Arjo Vanderjagt (eds.), *Between Demonstration and Imagination* (Leiden: Brill, 1999), pp. 243–67; Grant, 'God and Natural Philosophy: the Late Middle Ages and Sir Isaac Newton', *Early Science and Medicine* 5 (2000), 279–98.
- 14 Funkenstein, *Theology and the Scientific Imagination*, pp. 1, 4.
- 15 S. Gaukroger, *The Emergence of a Scientific Culture* (Oxford: Clarendon Press, 2006), pp. 506, 3.
- 16 F. Patrizi, *Nova de Universis Philosophia* (Ferrara, 1591); P.J. Forshaw, 'Vitriolic Reactions: Orthodox Responses to the Alchemical Exegesis of Genesis', in K. Killeen and P.J. Forshaw (eds.), *The Word and the World* (Basingstoke: Palgrave, 2007), pp. 111–36. Thomas Sprat, *History of the Royal Society* (London, 1667), pp. 371–2.
- 17 M. Hunter, 'Science and Heterodoxy: an Early Modern Problem Reconsidered', in D.C. Lindberg and R.S. Westman (eds.), *Reappraisals of the Scientific Revolution* (Cambridge University Press, 1990), pp. 437–60; M. Hunter and D. Wooton (eds.), *Atheism from the Reformation to the Enlightenment* (Oxford: Clarendon Press, 1992); R.H. Popkin, *The History of Scepticism from Savonarola to Bayle* (Oxford University Press, 2003).
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- 21 I.B. Cohen (ed.), *Puritanism and the Rise of Modern Science: the Merton Thesis* (New Brunswick: Rutgers University Press, 1990), pp. 145–58; Robert K. Merton, *Science, Technology and Society in Seventeenth-Century England* (New York: Fertig, 1970).
- 22 Max Weber, *The Protestant Ethic and the Spirit of Capitalism* (London: George Allen and Unwin, 1930). But see also S. Shapin, 'Understanding the Merton Thesis', *Isis* 79 (1988), 594–605.
- 23 Merton, *Science, Technology and Society*, p. 93.
- 24 Cohen, *Puritanism and the Rise of Modern Science*; Shapin, 'Understanding the Merton Thesis'.
- 25 C. Webster, *The Great Instauration* (London: Duckworth, 1975); F. Bacon, *Novum Organum* (London, 1620), Book II, Aphorism 52. On

- Bacon's own religious position, see S. Matthews, *Theology and Science in the Thought of Francis Bacon* (Aldershot: Ashgate, 2008).
- 26 Webster effectively concedes this point, *Great Instauration*, pp. 517–20.
 - 27 L. Mulligan, 'Civil War Politics, Religion and the Royal Society', and B.J. Shapiro, 'Latitudinarianism and Science in Seventeenth-Century England', both in C. Webster (ed.), *The Intellectual Revolution of the Seventeenth Century* (London: Routledge and Kegan Paul, 1974), pp. 317–39 and 286–316; J. Henry, 'England', in R. Porter and M. Teich (eds.), *The Scientific Revolution in National Context* (Cambridge University Press, 1992), pp. 178–210.
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 - 29 P. Harrison, *The Bible, Protestantism, and the Rise of Natural Science* (Cambridge University Press, 1998), p. 266.
 - 30 Gaukroger, *Emergence of a Scientific Culture*, p. 507.
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 - 38 P. Harrison, *The Fall of Man and the Foundations of Modern Science* (Cambridge University Press, 2007), p. 43.
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 - 40 Popkin, *The History of Scepticism*; H.G. van Leeuwen, *The Problem of Certainty in English Thought, 1630–1690* (Dordrecht: Kluwer, 1970);

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