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Robert Boyle's Religious Life, Attitudes, and Vocation¹

Robert Boyle is an outstanding example of a Christian scientist whose faith interacted fundamentally with his science. His remarkable piety was the driving force behind his interest in science and his Christian character shaped the ways in which he conducted his scientific life. A deep love for scripture, coupled ironically with a lifelong struggle with religious doubt, led him to write several important books relating scientific and religious knowledge. Ultimately, he was attracted to the mechanical philosophy because he thought it was theologically superior to traditional Aristotelian natural philosophy: by denying the existence of a quasi-divine 'Nature' that functioned as an intermediary between God and the world, it more clearly preserved God's sovereignty and more powerfully motivated people to worship their creator.

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I read your Theologie as the Life of your Philosophie, & your Philosophie as animated & dignified by your Theologie; yea indeed as its first Part.

Richard Baxter²

Robert Boyle is best known today as the person who published 'Boyle's Law', the inverse relation between the pressure and volume of what we now call gases that is a standard part of a basic chemistry course. He also wrote extensively about other properties of matter in all three of its basic phases (liquid, solid, and gaseous) and important aspects of physiology, medicine, the earth (including the oceans and the atmosphere) and the philosophy of science. Because of his many important scientific discoveries, we typically think of Boyle as 'the father of chemistry and brother of the Earl of Cork', to borrow an old witticism. What is absent from this popular image, however, is a deeper understanding of the deeply religious man who wrote as much about the nature of God as he did about the nature of air.

Evidence related to Boyle's religiosity is indeed substantial, and in recent years scholarly attention devoted to this and other aspects of his life has

1 The earliest version of this paper was given at the Massachusetts Institute of Technology in January 1998; I returned in January 2006 to give the most recent version. A much shorter version appeared in issue 76 of *Christian History* magazine. Used by permission. I have drawn heavily on another version, 'Science as Christian vocation: The case of Robert Boyle', in Menuge, A. (ed.) *Reading God's World: The Scientific Vocation*, Concordia Publishing House (2004), pp. 189–210. Comments from Denis Alexander, Peter Anstey and two anonymous reviewers have been helpful.

2 Baxter, R. to Robert Boyle, (14 June 1665), in Hunter, M., Clericuzio, A., Principe, L.M. (eds.) *The Correspondence of Robert Boyle*, 6 vols. London: Pickering & Chatto (2001), II, p. 473.

greatly increased. Twenty years ago it might have been possible in a short article to provide a comprehensive overview of this topic.³ Now however we simply know too much, and much of what we have learned reveals hitherto overlooked complexities in his personality and behaviour – even if we ignore efforts formally to psychoanalyse him.⁴ No short and simple account is likely to be fully satisfactory. Keeping this in mind, I have not attempted to write a scholarly essay in the usual sense of that term: it breaks very little new ground, introduces just a smattering of new information and says nothing that would surprise anyone with a good working knowledge of Boyle's life. Nor will I go very far into the larger interpretive issues that typically concern historians when confronted with a wealth of information about someone of great importance. I wish simply to provide a clear window into the practices, beliefs, and attitudes of someone who saw himself resolutely as a Christian virtuoso – a Christian scientist, we would say today, the word 'scientist' not having been coined until the 1830s.

And already we are faced with one of those larger interpretive problems: like anyone else, Boyle did not always see himself as he actually was, and he did not always present himself as we have found him to be; a few examples are mentioned below. Nevertheless on many points his actions and character, as far as we can tell more than three centuries after his death, actually were very close to that of the Christian virtuoso whom he described in his writings. Considering all the historical work that has been done, we still find that the depth, extent and sincerity of his Christian beliefs and spirituality emerge as unchallenged features of his biography. As Michael Hunter has very recently said, 'The central fact of Boyle's life from his adolescence onwards was his deep piety, and it is impossible to understand him without doing justice to this.'⁵ What follows should be understood as my effort to do it justice.

Who Was Robert Boyle?

Bombarded by deafening claps of thunder in the dead of night, an adolescent boy awoke suddenly from a deep sleep, terrified by the loud darkness, punctuated by staccato flashes of light so frequent and dazzling that he imagined himself amidst the fire that would someday consume the world on the day of judg-

3 It should be noted that Reijer Hooykaas' insightful wartime analysis, *Robert Boyle: A Study in Science and Christian Belief*, Dyke, V.D. (trans.), Lanham, MD: University Press of America (1997), was hard to obtain and not yet available in English.

4 See, for e.g., 'Psychoanalysing Robert Boyle', a special issue of *British Journal for the History of Science* (1994) that contains article by Michael Hunter (who also edited the issue), Brett Kahr, John Clay, and Karl Figlio, with commentary by Geoffrey Cantor. I sympathise with Cantor's view (p. 319) that such efforts wrongly imply 'that Boyle's interest in religion bordered on the unhealthy and medically pathological', and I affirm his overall conclusion (p. 323) that 'the papers by the three analysts show how difficult it is to transform those [psychoanalytic] insights into convincing historical arguments.'

5 Quoting Hunter's article on Boyle, in *Oxford Dictionary of National Biography*, Oxford: Oxford University Press (2004), VII, p. 106.

ment. Trembling at the hideous thought of being unprepared to face the awesome finality of that dreadful day, he solemnly resolved to live more piously henceforth. Robert Boyle kept that vow with remarkable consistency, and dated his conversion from that awful night.

Within months, however, his faith came under attack. As Boyle described it in a third-person memoir he wrote in his early twenties, he became deeply depressed during a casual visit to the original Carthusian abbey of Grande Chartreuse in 'those Wild Mountaines' near Grenoble. In commenting on this passage, Jack MacIntosh points out that many of Boyle's contemporaries were distressed by mountains, and this may have contributed to the dark mood that overcame him on this occasion.⁶ There in the mountains, 'the Devil taking advantage of that deepe, raving Melancholy, [and] so sad a Place', combined with 'the st[r]ange storys & Pictures he found there of [Saint] Bruno the Father Patriark of that order; suggested such strange & hideous thoughts, & such distracting Doubts of some of the Fundamentals of Christianity', that he even contemplated suicide. Only 'the Forbiddenesse of Selfe-dispatch' prevented him from taking that fatal step. 'But after a tedious languishment of many months in this tedious perplexity', he reflected, 'at last it pleas'd God one Day he had receiv'd the Sacrament, to restore unto him the withdrawne sence of his Favor.' Although the youthful Boyle saw 'those impious suggestions, rather as Temptations to be suppress't [or] rejected then Doubts to be resolv'd; yet never after did these fleeting Clouds, cease now & then to darken the clearest serenity of his quiet.'⁷ 'Of my own Private, & generally unheeded doubts', he wrote just a few years later, 'I could exhibit no short Catalogue...'⁸

To some extent, I think, the hesitation evident in such passages relates to the intense scrupulousness with which Boyle approached moral decisions. Michael Hunter has analysed a fascinating set of notes on conversations about casuistry that Boyle had with bishops Gilbert Burnet and Edward Stillingfleet about six months before his death, and we know that his interest in such matters was longstanding and considerable.⁹ Religious doubt certainly remained a defining characteristic of Boyle's personality. Many of his mature works can be seen as parts of a lifelong conversation with his own soul. As Richard S. Westfall observed nearly fifty years ago, the extensive attention that Boyle and some other virtuosi gave to 'answering hypothetical atheists' was really more

6 'An account of Philaretus during his minority', In Hunter, M. (ed.) *Robert Boyle: By Himself and His Friends*, London: Pickering & Chatto (1994), p. 17; MacIntosh, J.J., *Boyle on Atheism*, Toronto: University of Toronto Press (2005), pp. 24-25.

7 *ibid.* In *Occasional Reflections*, much of which was also written early in his life, Boyle compares 'Prophane or Atheistical wits' to 'the black Clouds that then over-cast the Sky', accompanied by 'affrighting Thunder, and hurtful Storms'. See Hunter, M., Davis E.B. (eds.) *The Works of Robert Boyle*, 14 vols, London: Pickering & Chatto (1999-2000), V, pp. 37-38. Henceforth all references to Boyle's writings (unless otherwise indicated) are to this edition.

8 Boyle, R., 'Essay of the Holy Scriptures', *Works* XIII, p. 180.

9 Hunter, 'Casuistry in action: Robert Boyle's confessional interviews with Gilbert Burnet and Edward Stillingfleet, 1691', *Journal of Ecclesiastical History* (1993) 44, 80-98.

of an effort 'to satisfy their own doubts' about the implications of the new science.¹⁰ What Westfall failed to see, however, is the positive role that doubt played in the construction of Boyle's faith. His approach to doubt – the other side of the coin of faith – was frankly precocious. Not long after his twentieth birthday, in a notebook entitled 'Diurnall Observations, Thoughts, & Collections', Boyle recorded the following aphorism: 'He whose Faith never Doubted, may justly doubt of his Faith.' Immediately before this, he had written, 'The Dialect of Faith runs much upon the First Person[;] or True Faith speaks always in the First Person.'¹¹ Boyle understood both intuitively and cognitively a crucial fact about religious faith: it is a highly personal matter, and only those who take steps to examine their own beliefs can really lay claim to them and live accordingly.

Boyle's faith was indeed his own, a product of thoughtful reflection as well as religious experience. 'I am not a *Christian*, because it is the Religion of my Countrey, and my Friends', he confessed at one point. 'I admit no mans Opinions in the whole lump, and have not scrupled, on occasion, to own dissents from the generality of learned men, whether Philosophers or Divines: And when I choose to travel in the beaten Road, 'tis not because I find 'tis the Road, but because I judge 'tis the Way.'¹² Precisely what Boyle meant by this, is best seen in a highly interesting unpublished treatise 'On the Diversity of Religions' that survives among his papers. '[N]ot only do far fewer religions differ fundamentally than men perceive', he observed,

but far fewer men follow any of those religions of their own choice than some believe. For it is one thing for a man to profess this or that religion, but another thing entirely for him to choose the best. For the latter cannot be done save by one who has seriously and carefully examined the religion he has embraced in preference to others, and has compared it with them. But unless this serious and deliberate choice has taken place, one cannot legitimately conclude from the number of men adhering to that religion that it is the best... Thus, when all things are duly considered, we may readily note that there are few who choose a given religion, even though there are many who follow it, for the rest all behave passively, so to speak, each man professing his religion more by chance than by judicious choice.

10 Westfall, *Science and Religion in Seventeenth-Century England*, New Haven: Yale University Press (1958), p. 145; cf. pp. 219-220. Some of Westfall's other conclusions about Boyle's religious life and thought are less convincing.

11 Royal Society, Boyle Papers, vol. 44, fol. 95. This notebook, begun in April 1647, consists mainly of lengthy passages copied out of French romances; see Principe, L.M. 'Virtuous romance and romantic virtuoso: The shaping of Robert Boyle's literary style', *Journal of the History of Ideas* (1995) 56, 377-397, esp. p. 381. The first few pages, however, are in English, and it is unclear whether Boyle wrote some of them himself or took them all from unidentified sources. Either way, it is clear that the sentiments were important to him. Michael Hunter has made this text available at <http://www.livesandletters.ac.uk/wd/>.

12 Boyle, R. *Reason and Religion, Works VIII*, p. 241. For similar passages, see Boyle, R. *Christian Virtuoso, I, Appendix, Works XII*, p. 421, and Boyle Papers, vol. 7, fol. 233.

Not surprisingly, his overall conclusion was, 'That a wise Christian should not be disturbed by the number and diversity of religions.'¹³ Nevertheless, Boyle knew more than most Englishmen about religions other than Christianity, and he was well read in the doctrinal controversies among Christians – especially those related to Socinianism, which he regarded as a dangerous heresy. He knew and respected the great Amsterdam rabbi Manasseh ben Israel, discussed the Hebrew language and Jewish beliefs with a Jewish scholar in London¹⁴ and even tried learning Arabic before weakening eyesight forced him to abandon the project. He actively sought conversation with Jewish scholars, regarding such 'Fundamentall Controversys' as 'both more Necessary & more Worthy a Wise mans Study, then most of those, comparatively Trifling ones, that at present so miserably (not to say so Causelessly) distract Christendome.'¹⁵

Having taken full ownership of his faith, Boyle cultivated an active piety that friends noticed and admired – above all in his strict habit of honouring God's name. Before he turned twenty-one, he wrote two essays on the spiritual damage done by swearing that were published after his death. Nor was he the least bit hypocritical in writing them. His confidant Burnet remarked on this decades later in his funeral oration, stating that Boyle 'had the profoundest Veneration for the great *God of Heaven and Earth*, that I have ever observed in any Person. The very name of God was never mentioned by him without a Pause and a visible stop in his Discourse.'¹⁶ So careful was Boyle's adherence to this practice, that longtime friends could not recall his ever failing in it. Sir Peter Pett once asked him about this, only to be told, 'not to have an awe upon us when the name of God is spoken of in Company, is a sign of want of Grace.'¹⁷

Boyle approached the Bible with a similar reverence, so much so that he gently reprov'd anyone who would use the words of Scripture in jest. As Pett recalled, 'he inculcated the sinfulness of men's diminishing thereby the constant awe that the Scriptures should have on their thoughts: and minded the company of the Words of Isaiah to him will I look, who is of contrite heart & trembles at my word.'¹⁸

Morning devotions were a standard part of his daily routine, despite his poor eyesight.¹⁹ Judging from the number of times he cited it, one of his favourite verses was 1 Peter 1:12. In keeping with this verse he hoped for a 'dayly

13 Boyle, R. 'On the diversity of religions', as translated in *Works* XIV, pp. 237-264, quoting pp. 255-256 and 237.

14 The identity of this scholar is not known. Boyle mentioned this in a letter to his friend John Mallet in November 1651, *Correspondence* I, p. 104.

15 Boyle, R. 'Essay of the Holy Scriptures', *Works* XIII, p. 217.

16 Burnet, *A Sermon Preached at the Funeral of the Honourable Robert Boyle*, London (1692), In Hunter, M. (ed.) *op. cit.*, [6], p. 48. Burnet's italics quote a common biblical reference to God.

17 'Sir Peter Pett's Notes on Boyle', In Hunter, M. (ed.) *op. cit.*, [6], p. 67.

18 *ibid.*, p. 66, quoting Isa. 66:2.

19 'John Evelyn's letter to William Wotton', In Hunter, M. (ed.) *op. cit.*, [6], p. 88.

encrease' in the number of those 'who have such a desire as St. *Peter* tells us the Angels themselves cherish, to look into the Mysteries of Religion, and are qualified with elevated and comprehensive Intellects to apprehend them in some measure.'²⁰ This is precisely what Boyle tried to do himself: to develop a very serious interest in biblical scholarship, a trend apparently dating back to his youthful trip to the Continent. According to Burnet, in Florence Boyle met a Jewish refugee from Spanish persecution, a man with whom he 'had many discourses about the Scriptures,' and 'this led him first to enquire into them.' Several years later his father's close friend, the great biblical scholar Archbishop James Ussher (the same man famous today for calculating of the date of creation), reproached him for being ignorant of Greek, so 'he studied it and read the N[ew] Test[ament] in that Language so much that he could have quoted it as readily in Greek as in English'.²¹ As his eyes dimmed, he had to give up studying Hebrew, which none of his servants could read, but he was able to get help reading Greek.²² Nevertheless, Pett reported that Boyle 'alwaies had in his hand' in church a copy of the Bible in the original languages, which he liked to compare with the reading of the chapters assigned for that Sunday, 'wondring to heare our English translation so different' from the original.²³

His love for God found further expression in love for his fellow human beings, starting with the tenants of his estate at Stalbridge, the poorest of whom annually received a cash gift at Christmas; he also instructed his bailiff not to oppress them with onerous rents. On other occasions, money would accompany medicines Boyle had made in his own laboratory for sick paupers.²⁴ Many felt the gentle hand of his love, freely given and gratefully accepted. 'His Charity to those that were in Want', Burnet reminded Boyle's friends at his funeral, was 'so very extraordinary, and so many did partake of them, that I may spend little time on this Article. Great Summs went easily from him, without the Partialities of Sect, Country, or Relations; for he considered himself as part of the Humane Nature, and as a Debtor to the whole Race of Men.' Burnet knew of what he spoke: he had served often as an intermediary in Boyle's giving, helping to keep Boyle's identity secret. The donations he could vouch for sometimes exceeded £1000 per year, a very significant sum at the time.²⁵ He also supported expensive projects to translate the Bible into Welsh, Irish, Turkish, Malayan and the language of the Indians in Massachusetts, as well as Edward Pococke's Arabic translation of Hugo Grotius' important treatise, *On the Truth of the Christian Religion*.

Christian love is also seen in Boyle's attitude toward individual persons in

20 Boyle, R. *Style of the Scriptures*, Works II, p. 401.

21 'Burnet Memorandum', In Hunter, M. (ed.) *op. cit.*, [6], p. 27-28.

22 Burnet, *op. cit.*, [16], p. 47.

23 'Sir Peter Pett's Notes', *op. cit.*, [17], p. 65. Apparently Pett got this information from Thomas Hyde, who knew Boyle for many years and was Bodley's Librarian from 1665 to 1701.

24 'Thomas Dent's letter to William Wotton', In Hunter, M. (ed.) *op. cit.*, [6], p. 105.

25 Burnet, *op. cit.*, [16], p. 52.

ordinary discourse. As Burnet said, 'When he differed from any, he expressed himself in so humble and so obliging a way, that he never treated Things or Persons with neglect, and I never heard that he offended any one Person in his whole Life by any part of his Deportment.'²⁶ Boyle's approach to intellectual opponents was identical, going out of his way on several occasions to treat their positions fairly and their persons graciously, avoiding gratuitous *ad hominem* comments. 'I love to speak of Persons with Civility, though of Things with Freedom', he announced in one of his first books. 'I think such a quarrelsome and injurious way of writing does very much mis-become both a Philosopher and a Christian.'²⁷ Elsewhere I have shown the extent to which Boyle consistently kept this policy.²⁸ Overall, Boyle left a truly remarkable legacy on this score. Although he was constantly in the public eye, often writing on controversial subjects and speaking with a wide range of people, Boyle seems to have had intellectual opponents but no real enemies – except philosopher Thomas Hobbes, a truculent man 'whose hand was against every body, & admir'd nothing but his owne', to borrow the words of John Evelyn.²⁹

In the early 1660s, Hobbes and Boyle clashed over how to understand some of Boyle's experiments with air pumps. Above all, they argued about how to interpret (both in physical and metaphysical terms) the space above the meniscus in a mercury barometer: Is it really empty? How do we know that the air-pump is a reliable scientific instrument? Boyle saw Hobbes' concept of a corporeal God as 'dangerous' to religion, and he was undoubtedly eager to respond vigorously for that reason alone. He was also frustrated by Hobbes' persistent attack on scientific knowledge itself and Hobbes' condescending tone toward Boyle and his colleagues in the early Royal Society. Nevertheless, even here Boyle sought to mollify rather than to escalate. His reply was calculated 'to give an Example of Disputing in Print against a Provoking, though unprovoked, Adversary, without Bitterness and Incivility, and without pursuing those things which [belong more]... to the Person of an Antagonist then to his Cause.' Inviting Hobbes to respond, Boyle advised 'that his Reply be as inoffensive as I have endeavour'd to make [mine]', lest others be inclined to return his incivility.³⁰

Boyle exhibited a similar charity in matters of conscience, proving more ecumenical than many of his countrymen. Although he always supported the established church, as his pastor (Stalbridge rector Thomas Dent) duly noted,

26 *ibid.*, pp. 50-51.

27 Boyle, R. *Certain Physiological Essays, Works II*, p. 26.

28 See my essay, ' "Parcere nominibus": Boyle, Hooke, and the rhetorical interpretation of Descartes', In Hunter, M. (ed.) *Robert Boyle Reconsidered*, Cambridge: Cambridge University Press (1994), pp. 157-175.

29 *op. cit.*, [19], p. 89.

30 Boyle, R. *Examen of Hobbes, Works III*, pp. 111 and 114. For a wide-ranging discussion of the issues at hand, see Shapin, S. and Schaffer, S., *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*, Princeton: Princeton University Press (1985). For critical comments on their interpretation, see Hunter, M., *Robert Boyle (1627-1691): Scrupulosity and Science*, Woodbridge: The Boydell Press (2000), pp. 8-10.

he 'was for moderation to those, who dissented from us, & not to force Tender consciences-for which he seem'd to expresse great aversen[ess].'³¹ According to Burnet, 'He had a most peculiar zeal against all Severities and Persecutions upon the account of Religion. I have seldom observ'd him to speak with more Heat and Indignation, than when that came in his way.' Boyle not only considered religious persecution 'Immorall', he also 'loved no Practice' that 'occasioned Divisions amongst Christians'. He tried to foster a 'pure and disinterested Christianity' and 'was much troubled at the Disputes and Divisions which had arisen about some lesser Matters, while the Great and the most Important, as well as the most universally acknowledged Truths were by all sides almost as generally neglected as they were confessed.'³² While Parliament was considering an ordinance (passed in May 1648) making heresy a capital crime, the young Boyle wrote to his former tutor to express his dissent, saying,

Why a man should be hanged, because it has not yet pleased God to give him his spirit, I confess, I am yet to understand. Certainly to think by a halter to let new light into the understanding, or by the tortures of the body to heal the errors of the mind, seems to me like applying a plaister to the heel, to cure a wound in the head; which doth not work upon the seat of the disease.³³

The ecumenical attitude evident in much of Boyle's writings has long made me suspicious of several scholarly works that present Boyle as an anti-Catholic thinker and writer, based on the widely accepted assumption that Boyle wrote an anonymous controversialist tract called *Reasons Why a Protestant should not Turn Papist*. Upon deeper investigation several years ago, primarily motivated by the generous picture of Boyle I have presented, I discovered that he did not write it. The real author was the Scottish physician David Abercromby, a former Jesuit who had become a Protestant and who worked for Boyle in the 1680s.³⁴

The source of Boyle's ecumenism is often said vaguely to be his sympathy with the broadly tolerant 'Latitudinarian' wing of the Anglican church, which sought to avoid both a rigid Calvinism on the one hand and an equally rigid Catholicism on the other hand. It is more helpful to point to some specific intellectual influences early in Boyle's life. Much work remains to be done on this important topic, but the best suggestion I have seen thus far is that of Peter Anstey, who stresses the significance of two different but somewhat overlap-

31 *op. cit.*, [24], p. 105.

32 Burnet, *op. cit.*, [16], pp. 48-49, and *op. cit.*, [21], p. 28.

33 Boyle, R. to Isaac Marcombes, (22 October 1646), *Correspondence* I, p. 40.

34 See my article, 'The anonymous works of Robert Boyle and the *Reasons Why a Protestant Should not Turn Papist* (1687)', *Journal of the History of Ideas* (1994) 55, 611-629. Raymond D. Tumbleson has contested my conclusion in *Catholicism in the English Protestant Imagination*, Cambridge: Cambridge University Press (1998), p. 230 note 31, but he neither engages my argument nor refutes the evidence I gathered. In his entry on Abercromby in *Oxford Dictionary of National Biography*, the late Paul Tomassi granted 'considerable plausibility' to my conclusion.

ping sources. One was the Dutch statesman and jurist Hugo Grotius, author of the widely read pamphlet, *On the Truth of the Christian Religion* (1627), which Boyle admired – he customarily referred to him as ‘the Excellent Grotius’, and he paid for Pococke’s Arabic translation of that book while Puritan theologians John Owen and Richard Baxter were trying to discredit Grotius. With his countryman Jacob Hermensen (better known by his Latin name ‘Arminius’), Grotius admired the tolerant Christian humanism of Erasmus at a time when religious wars were tearing the fabric of Christendom. Grotius hoped that reason might be able to sort out religious differences among Christians while at the same time showing the overall truth of Christianity. In England, Grotius’ attitude was adopted and his ideas were adapted by several members of the ‘Great Tew’ circle, a group of men who gathered for intellectual exchanges at the home of Lucius Cary, Lord Falkland, in the village of Great Tew near Oxford. Boyle knew Falkland and some other members of the circle, who were (like Grotius) sometimes accused of being Socinians. Boyle himself was very clearly not a Socinian, but the charitable approach of Erasmus’ disciples seems to have shaped his thoughts, words, and deeds.³⁵

A complementary influence, as John Harwood has shown, was the massive Encyclopædia (1630) compiled by German theologian Johann Alsted, under whom Czech educational reformer Johann Comenius studied. Boyle consulted it heavily in his twentieth year, while he was busy at work on a lengthy essay about happiness and moral virtue that he never published. It was through writing this and some other early essays, Harwood argues, that Boyle ‘found a vocation, a concept crucial to the moral life’.³⁶ Boyle did this self-consciously, and he understood its significance at the time, stressing that ‘it is very requisite (if not absolutely necessary) to settle our Youth... in a fit Vocation,... because’, first of all, ‘A Convenient civil Calling is a sovveraigne Preservative agenst Idleness, (that mother of Vices) and an excellent prevention of a world of Idle, Melancholick and exorbitant thouhts, and un-warrantable Actions.’ What follows shortly is one of the most revealing statements Boyle ever entrusted to paper: ‘He is but an useless wastful Droane, and unworthy of the Benefits of Humane Society; whose endeavors in som honest particular Calling, do not som way or other Cooperate (and contribute) to the Good of the Common-welth.’ ‘While a Gentleman’, he went on to say, is

busyng himself in any lawfull Employment that tends to the Good, of him-

35 Anstey, ‘The Christian virtuoso and the reformers: Are there reformation roots to Boyle’s natural philosophy?’, *Lucas: An Evangelical History Review* nos. 27 & 28 (June and December 2000): 5-40. On Grotius and the Great Tew circle, see Beiser, F.C. *The Sovereignty of Reason: The Defense of Rationality in the Early English Enlightenment*, Princeton: Princeton University Press (1996), pp. 84-133, although Beiser does not link this group directly with Boyle. Beiser also spells out the tensions between English Arminians and the Great Tew circle: the story is more complicated than I can tell it here. For a detailed account of Boyle’s thoughts on Socinianism and religious toleration, see Wojcik, J.W. *Robert Boyle and the Limits of Reason*, Cambridge: Cambridge University Press (1997), esp. pp. 14-24 and 55-59.

36 Harwood, J. *The Early Essays and Ethics of Robert Boyle*, Carbondale, Illinois: Southern Illinois University Press (1991), p. xlv.

self, his Family, others, or the Commonwealth, he may be (favourably) thought to be diligent to embrace in his Profession. But when a Gentleman... shall spend his whole stock of precious time in Carding, Dicing, Hunting, revelling, Seeing of Plays, Reading of Romances, Powdring his haire, Staring upon looking-glasses, courting of Ladys that he means not to marry (not to mention what is worse) and in Sum make Vacation his only Vocation: he must have a Stronger Charity than Judgment, that believes that God and Nature intended only this for that man's Calling.

Though Boyle dearly hoped that 'we have not too many' like the latter, his circumstances must have provided abundant opportunities for second thoughts.³⁷

Boyle's Early Life

Manifestly, his circumstances did not suggest that Boyle would become a scientist. Born in January 1627, he was the seventh son and fourteenth child of the second wife of Richard Boyle, the first Earl of Cork. In his diary the Earl projected a pious, God-fearing image of himself, but in reality he was an unscrupulous man who took advantage of English colonialism in Ireland to become one of the very wealthiest men in all the realm.³⁸ Young 'Robin', as he was called, watched as his thirteen older brothers and sisters became pawns in the hands of a power broker, the boys given titles and lands and the girls married off to the sons of other powerful men – who usually had more ardour for their houses and horses than for their wives. Robin's sister Katherine, Viscountess Ranelagh, was married at fifteen to Arthur Jones, a man described by family friend Sir John Leeke as 'the foulest Churle in the world; he hath only one vertu that he seldom cometh sober to bedd, a true imitation of Sir Robt Wroth', a drunken wastrel and womaniser who had died penniless in 1614.³⁹ 'Kate' lived apart from her husband for many years before his timely death made her final twenty-two years a much happier time. Their brother Francis, all of sixteen years himself, was torn from his seventeen-year-old wife Elizabeth, daughter of a deceased Vice-Chamberlain to Queen Henrietta Maria, four days after their hasty wedding at the Royal Chapel of Whitehall and sent with Robin on the Grand Tour for two and a half years. (To be fair to the Earl, however, in this case it was the bride's mother who insisted that her daughter be married before her betrothed left for the Continent.) 'Betty', whose brother Sir Thomas Killigrew employed Charles II's mistress Nell Gwyn at his Theatre

37 Boyle, R. 'The Aretology'; in Harwood, J., *op cit.*, [36], pp. 85 and 88.

38 On Cork's dealings, see Ranger, T.O. 'Richard Boyle and the making of an Irish fortune, 1588-1614', *Irish Historical Studies* (1957) 10, 257-297; and Canny, N. *The Upstart Earl: A Study of the Social and Mental World of Richard Boyle, First Earl of Cork, 1566-1643*, Cambridge: Cambridge University Press (1982).

39 Verney, F.P. *Memoirs of the Verney Family*, 4 vols, London: Longmans (1892), I, p. 206.

Royal in Drury Lane, likewise found fame as a mistress who bore Charles II a daughter. Venereal disease prevented Lewis Boyle, almost eight years older than Robin, from consummating his marriage, and Roger Boyle (about two years younger than Lewis) was said by his own fiancée to have had gonorrhoea.⁴⁰ With such examples close at hand, it is little wonder that Boyle took a very dim view of courtly mores.

The youthful Robin narrowly avoided an arranged marriage himself, and later dodged the well-intended effort of his good friend John Wallis (the Oxford mathematician) to match him up with an eligible woman from a wealthy family. Boyle remained not only unmarried, but celibate his entire life. To the best of our knowledge, the closest he ever came to having sexual relations was during a visit to Florence with his brother Frank and their tutor in 1642, in Robin's sixteenth year. By his own recollection six or seven years later, he sometimes 'in his Governor's Company' visited 'the famossest Bordellos; whither resorting out of bare Curiosity, he retain'd there an unblemish't Chastity, & still return'd thence as honest as he went thither'. On another occasion, however,

he prov'd the Object of unnaturall [desires]. For being at that Time in the Flower of Youth, & the Cares of the World having not yet stain'd a Complexion naturally fresh enuf; as he was once unaccompany'd diverting himselfe abroad, he was somewhat rudely storm'd by the Preposterous Courtship of 2 of those Fryers, whose Lust makes no Distinction of Sexes, but that which it's Preference of their owne creates; & not without Difficulty, & Danger, forc't a scape from these gown'd Sodomites. Whose Goatish Heates, serv'd not a little to arme [him] against such Peoples specious Hypocrisy; & heightn'd & fortify'd in him an Aversenese for Opinions, which now the Religieux discredit as well as the Religion.⁴¹

Many years later he told Burnet that he had 'Abstained from purposes of marriage at first out of Policy afterwards more Philosophically'.⁴² In his first published book, which extolled 'the Joyes of *Seraphick Love*' over merely human romance, he commented more fully. 'I am no such enemy to Matrimony, as some (for want of understanding the Raillery, I have sometimes us'd in ordinary discourse) are pleased to think me', he claimed. Without skipping a breath, he added, 'yet I have observed so few Happy Matches, and so many Unfortunate ones; and have so rarely seen men love their wives at the rate they did, whilst they were their Mistresses, that I wonder not, that Legislators thought it necessary to make marriages Indissoluble, to make them Lasting'. Comparing marriage to a lottery, he noted that both offered a chance for suc-

40 This information comes from Shapin, S. *A Social History of Truth: Civility and Science in Seventeenth-Century England*, Chicago: University of Chicago Press (1994), p. 138.

41 'An account of Philaretus during his minority', In Hunter, M. (ed.) *op. cit.*, [6], p. 20.
42 *op. cit.*, [21], p. 27.

cess, 'But in both Lotteries, there lye a pretty store of Blancks for every Prize.'⁴³ Having seen many women try to make the best of bad marriages, Boyle advised the woman who wanted to be a good wife, 'to deliberate much upon a Choice she can probably make but once; and not needlessly venture to embarque herself on a Sea so infamous for frequent Shipwracks, only because she is offer'd a fine Ship to make the long Voyage with'.⁴⁴

Although she was twelve years older, the unhappily married Katherine became Robin's closest confidant. Although she left no significant writings of her own, she was by all accounts a brilliant woman who, according to Leeke, 'hath a memory that will hear a sermon and goe home and penn itt after dinner verbatim'.⁴⁵ In her London home she convened a salon for important intellectuals, including John Milton (who tutored her son), Samuel Hartlib, and several members of Parliament. Her brother lived with her for much of his adult life, and Burnet's description of her character strongly suggests that he learned much from her:

She employed [her whole life] for doing good to others, in which she laid out her Time, her Interest, and her Estate, with the greatest Zeal and the most Success that I have ever known. She was indefatigable as well as dextrous in it: and as her great Understanding, and the vast Esteem she was in, made all Persons in their several turns of Greatness, desire and value her Friendship; so she gave her self a clear Title to imploy her Interest with them for the Service of others, by this that she never made any use of it to any End or Design of her own.... When any Party was down, she had Credit and Zeal enough to serve them, and she employed that so effectually, that in the next Turn she had a new stock of Credit, which she laid out wholly in the Labour of Love, in which she spent her Life: and though some particular Opinions might shut her up in a divided Communion, yet her Soul was never of a Party: She divided her Charities and Friendships both, her Esteem as well as her Bounty, with the truest Regard to Merit, and her own Obligations, without any Difference, made upon the Account of Opinion.⁴⁶

Katherine was also deeply pious and well versed in theology, traits she shared with their sister Mary Rich, who unexpectedly became Countess of Warwick when her husband's elder brother died without a male heir in 1659. The

43 Boyle, R. *Seraphic Love*, Works I, pp. 81-82. In the early 'Diurnall Observations, Thoughts, & Collections', Boyle had written, 'Marriage is a Lottery: he that Gets a Written Scrowle gets much: but for one of those there are 200 blankes.' Boyle Papers, vol. 44, fol. 95. This text is also available at <http://www.livesandletters.ac.uk/wd/>.

44 Boyle, R. *Martyrdom of Theodora*, Works XI, p. 32.

45 Verney, *op. cit.*, [38], I, p. 203-204. For short accounts of her social and intellectual life, see Hunter, L. 'Sisters of the Royal Society: The Circle of Katherine Jones, Lady Ranelagh', In Hunter, L., Hutton, S. (eds.) *Women, Science and Medicine, 1500-1700*, Thrupp, Stroud, Gloucestershire: Sutton Publishing (1997), pp. 178-197; and Sarah Hutton's entry in *Oxford Dictionary of National Biography*.

46 Burnet, *op. cit.*, [16], p. 52-53.

previously worldly Mary experienced a religious conversion in her early twenties, brought on at least partly by the influence of her sister and brother. Some of the proverbs and meditations she compiled can only be described as profound; others were more practical but no less wise, such as her advice that, 'The best shield against slanderers is, to live so that none may believe them.' In a separate diary, Mary noted how Robin, Katherine and she would sometimes have 'holy discourse' together, or 'good and profitable discourse of things where-with we might edify one another'.⁴⁷ Her brother acknowledged her influence by dedicating his first published book, *Seraphic Love*, to her.

Robin had Kate's splendid example to inspire and the ostentatiously pious diary of a father whom he had hardly known to emulate. Nevertheless, as Steven Shapin has noted, 'the serious and systematic embrace of a reflectively religious life was relatively rare for someone of Boyle's condition and degree.'⁴⁸ His earliest writings, dating from around his twentieth birthday though not published (if at all) until many years afterward, reflect the intensity of his own intimate relationship with God. These include the essays on swearing; an ethical treatise; and various essays, reflections and romances on moral and religious subjects. One of the latter, *The Martyrdom of Theodora, And of Didymus*, became the basis for Handel's opera *Theodora*. Another work begun at this time and dedicated to Katherine, *Occasional Reflections Upon Several Subjects*, was popular with Puritans and remained in print for almost two hundred years. Richard Baxter told Boyle that 'your pious Meditations & Reflexions, do call to me for greater Reverence in the reading of them, & make me put off my hatt, as if I were in the Church', and 'your special way of *Occasionall Meditation*, I take to be exceeding usefull!'⁴⁹ Isaac Watts based a four-line hymn upon one section, which was later set to music by the colonial American composer William Billings as part of his anthem, *Creation*.⁵⁰ The following passage is typical for its tone and content: 'we must never venture to wander far from God, upon the Presumption that Death is far enough from us, but rather in the very height of our Jollities, we should endeavour to remember, that they who feast themselves to-day, may themselves prove Feasts for the Worms to-morrow.'⁵¹ Here Boyle expresses not a morbid interest in death, but an appropriate Christian recognition that a sense of our mortality is the foundation of morality.

47 Walker, A. *Memoir of Lady Warwick: also her diary, from A.D. 1666 to 1672, now first published: to which are added, extracts from her other writings*, London : Religious Tract Society (1847), pp. 38, 91, and 102. Mary Rich's life receives an interesting analysis in Mendelson, S.H. *The Mental World of Stuart Women: Three Studies*, Amherst: University of Massachusetts Press (1987), pp. 62-115.

48 Shapin, *op. cit.*, [40], p. 157.

49 *Correspondence* II, pp. 473 and 476.

50 For details, see my report, 'Robert Boyle as the source of an Isaac Watts text set for a William Billings anthem', *The Hymn: A Journal of Congregational Song* (2002) 53(1), 46-47.

51 Boyle, R. *Works* V, p. 153.

Science as Christian Vocation

It was only after writing many of these works, at some point in his twenty-third year, that Boyle embarked on serious scientific study, and from that point on his pursuit of natural philosophy continued unabated until his death.⁵² Often we do not know precisely why a given person is drawn to any specific activity and, as Mordechai Feingold has stressed, we must keep in mind the distinction between one's actual motivation for doing science and the justification one then offers for it. This caveat is especially relevant to the early modern period, when so many scientists were ordained ministers who felt tugged in opposite directions by their callings as clergy and their fascination with mathematics or natural philosophy.⁵³ Although Boyle was not ordained, we must still be careful not uncritically to equate his reasons for doing science with the justification he provided.

They were however very closely linked in his case. Clearly Boyle found himself enraptured by laboratory experiments, and just as clearly he viewed his activities *simultaneously* in theological terms. His own account of the experience is mythical in its allusion and proportion: 'Vulcan', he told his sister in August 1649, 'has so transported and bewitch'd mee, that as the Delights I tast in it, make me fancy my Laboratory a kind of Elizium; so as if the Threshold of it possest the quality the Poets ascrib'd to that Lethe their Fictions made men taste of before their Entrance into those seats of Blisse.' In the very same letter, however, Boyle alluded to 'those Morall speculations, with which my Chymicall Practices have entertained mee', mentioning in this connection 'a Discourse... of the Theologicall Use of Naturall Filosofhy; endeavoring to make the Contemplation of the Creatures contributory to the Instruction of the Prince, & to the Glory of the Author of them'.⁵⁴ This discourse was almost certainly an essay, 'Of the Study of the Booke of Nature', which he originally intended to include with the homilies and meditations comprising *Occasional Reflections* – strong evidence in itself of the intimate connection that Boyle saw, right from the start, between his highly developed religious life and his new interest in science. He was already profoundly convicted that the investigation of nature was a fundamentally religious enterprise. 'Both our Divines & our Philosophers', the essay begins, 'compose Man's Library of three cheife Bookes, which to Expound, apply & Rectify, is the Taske of the rest.' The '3 Volumes, are The Booke of Nature, the Book call'd Scripture, & the Booke of Conscience.' Having already written about the latter two, Boyle's goal here was to 'addict... all capable & Intelligent Persons to the neglected study of the First'.⁵⁵ Although he would later try carefully to maintain a formal public distinction

52 I am relying on the lucid account by Hunter, M. 'How Boyle became a scientist', *History of Science* (1995) 33, 59-103.

53 Feingold, 'Science as a calling? The Early Modern dilemma', *Science in Context* (2002) 15(1), 79-119.

54 Boyle, R. to Lady Ranelagh, (31 August 1649), *Correspondence I*, pp. 82-83.

55 Boyle, R. 'Of the Study of the Booke of Nature', *Works XIII*, p. 147.

between his 'philosophical' (i.e., scientific) and 'theological' writings, partly because religion and politics were supposed to be kept out of Royal Society business, the intimate interplay between scientific and religious ideas would henceforth be one of the most prominent features of his thought.

A further impulse was Boyle's strong desire to improve the human condition and to ameliorate suffering, particularly through the application of chemical knowledge to medicine. To some extent, Boyle's interest in medicine reflected some unfortunate encounters with unhelpful physicians and his own generally poor health – his friend John Evelyn described him as 'rather talle & slender of stature', but 'pale & much Emaciated', and his diet as 'extreamly Temperate & plaine'.⁵⁶ Yet it is clear that Boyle deeply felt that physicians had a religious duty to be more forthcoming with effective remedies, and to provide them even to those who could not afford to pay. The title of his very first published essay shows this quite well: 'Invitation to a free and generous Communication of Secrets and Receits in Physick' – in other words, a call for physicians and apothecaries to throw off the veil of secrecy and to make known the recipes for medicinal substances.⁵⁷ He further developed this theme in other early essays that later became part of his longest book, *Some Considerations touching the Usefulness of Experimentall Philosophy*. This included a number of recipes for medicines thought to be effective, in order to make them more widely available, especially among the poor. In the last few years of his life, he published a much larger collection of recipes for this very purpose, just as John Wesley did in the following century.

Once Boyle had begun the investigation of nature, he never slackened, and he found his Christian character ideally suited to his new activities. The highly competitive aspect of modern science sometimes hides the fact that science is a fundamentally cooperative enterprise, in which groups of people work toward common goals. Boyle's unquestioned honesty, unfailing charity and genuine interest in the public welfare helped him gain the respect and friendship of an important community of 'gentlemen', who met regularly in John Wilkins' rooms at Wadham College, Oxford, to view experiments and to discuss the latest scientific discoveries and ideas. When Wilkins moved to Cambridge in 1659, Boyle assumed the role of host. The following year, in November 1660, he and some of the same 'gentlemen' joined with several others to found the Royal Society. Boyle is identified as a member of the Society's governing council in the two earliest charters of 1662 and 1663.⁵⁸

56 *op. cit.*, [19], pp. 88-89. Evelyn's description of the mature Boyle contrasts rather sharply with Isaac Marcombes' description of the teenaged Boyle. In letters written to the Earl of Cork, his son is said to be 'very fatt' with cheeks 'as red as vermillion', and that he was 'tall and thicke'. See Maddison, R.E.W. 'The portraiture of the honourable Robert Boyle, F.R.S.', *Annals of Science* (1959) 15, 141-214 (p. 178).

57 For the text of this essay, see Boyle, R. *Works* I, pp. 1-9.

58 On Boyle's role in the early Royal Society, see Maddison, R.E.W. *The Life of the Honourable Robert Boyle F.R.S.*, London: Taylor & Francis (1969), pp. 98-100.

The next dozen years were the most productive of his life, earning him a worldwide reputation as the outstanding experimental scientist of his generation. His most famous contributions involved the use of an air pump, expertly made for him by Robert Hooke, a brilliant Oxford student who went on to become a great scientist himself. With this apparatus, Boyle demonstrated several properties of the air, confirming in clear and clever ways the hypothesis of Blaise Pascal and others that the atmosphere is a vast fluid like the ocean. Just as water pressure increases with depth, so air pressure depends on the height of the atmosphere. Several other experiments, involving insects and small mammals, helped to illuminate the connections among respiration, combustion and various components of the air.

The issue of animal experimentation calls for more comment. Although the Greco-Roman anatomist Galen had carried out numerous experiments on living animals – it is the only way in which many physiological phenomena might be seen – his methods were not employed again as part of a scientific research programme until the first quarter of the seventeenth century, when the Oxford physician William Harvey used vivisection to establish the circulation of the blood.⁵⁹ By the 1650s, animal experimentation was practised widely in England and had become indispensable for understanding respiration, in which Boyle and several of his contemporaries had keen interest. For this and other purposes, Boyle carried out numerous experiments involving live dogs, cats, birds, mice, frogs, snakes, worms and various insects; he often repeated what he called ‘the Experiment of killing Birds in a small Receiver’.⁶⁰ To some extent, animal experimentation was encouraged by René Descartes’ view that animals were merely machines lacking reason and sensation, a concept that became known as the ‘beast-machine’, but its influence can be overstated and Boyle did not accept it. He sometimes expressed remorse for laboratory animals and even showed compassion in some cases by declining to subject animals to multiple experiments. As Malcolm Oster has shown, Boyle considered gratuitous cruelty to animals blasphemous, while at the same time he believed it legitimate to use animals for experiments that would advance human knowledge.⁶¹

Looking now to other aspects of his science, Boyle published a weighty tome of observations on the effects of cold, drawing in part on his extensive collection of reports from experienced travellers to the northernmost parts of the globe. Some of these reports were taken out of books written by famous explorers, such as the vast collection called *Purchas His Pilgrims* that Boyle cited

59 On this point and other background for Boyle’s animal experimentation, see Guerrini, A. *Experimenting with Humans and Animals: From Galen to Animal Rights*, Baltimore: Johns Hopkins University Press (2003), pp. 23-47, and Frank R.G., Jr., *Harvey and the Oxford Physiologists*, Berkeley: University of California Press (1980), esp. pp. 142-163.

60 Boyle, R. *Spring of the Air, Works I*, p. 286.

61 Oster, ‘The ‘Beame of Diuinity’: animal suffering in the early thought of Robert Boyle’, *British Journal for the History of Science* (1989) 22, 151-180. For a somewhat different view, see J.J. MacIntosh, ‘Animals, Morality, and Robert Boyle’, *Dialogue* (1996) 35, 435-472.

repeatedly here and in other works. His interest in travel literature was typical for the period; although the precise contents of his library is not known, his situation was probably not much different from that of Isaac Newton and Robert Hooke, who both owned many books by navigators and other travellers. Other reports were excerpted from letters he received from people such as Samuel Collins, an Englishman who served as personal physician to Tsar Alexis Romanov, or from interviews he carried out with sea captains and others associated with the Hudson's Bay Company, which Boyle joined specifically in order to obtain information of this type. Boyle drew further on travellers' reports in other works, especially in some of the 'histories' of qualities he wrote about colours, gems, mineral waters, air, phosphorus, the sea and human blood. This was all very much in keeping with Francis Bacon's call to compile an extensive and reliable natural history from which generalisations could be drawn by induction.

In the same period, Boyle wrote most of his subtle book on the doctrine of creation, *A Free Enquiry Into the Vulgarly Receiv'd Notion of Nature*, which illustrates some of the reasons why he found the new science of his day so attractive theologically. The book opposed the prevailing 'vulgar' (or commonplace) concept of nature, ultimately derived from Aristotle and Galen. Adherents of this view tended to personify nature, saying (for example) that 'nature abhors a vacuum' or that 'nature does nothing in vain.' Boyle considered this idolatrous, since it effectively placed an intelligent, purposive agent, 'much like a kind of *Goddess*', between God and the world God had made. Noting that the Old Testament contained no 'word that properly signifies *Nature*, in the sense we take it in', Boyle argued for the theological superiority of explaining natural phenomena from the purely 'mechanical' properties and powers given to unintelligent matter by God at the creation, rather than by projecting human mental activities onto inert matter.⁶² In 1659, the Cambridge Platonist philosopher Henry More called this approach the '*Mechanick* philosophy', and two years later Boyle likewise called it 'the Mechanical Hypothesis or Philosophy'.⁶³ Only the mechanical philosophy, he believed, clearly underscored the sovereignty of God and located purpose where it properly belonged: in the creator's mind, not in some imaginary 'Nature'. Furthermore, the vulgar notion of nature was damaging 'not only to the Glory of God,... but also to the Discovery of his Works'. As long as 'Men allow themselves so general and easie a way, of rendring accounts of things that are difficult, as to attribute them to *Nature*; shame will not reduce them to a more industrious scrutiny into the Reasons of Things, and curiosity itself will move them to it the more faintly'. We would

62 Boyle, R. *Notion of Nature*, *Works* X, pp. 456 and 459.

63 Boyle, R. *Certain Physiological Essays*, *Works* II, p. 87. Many scholars (including me) have said that Boyle coined the term 'mechanical philosophy', but Peter Anstey points to More's similar term in *The Immortality of the Soul* (London: J. Flesher for William Morden, 1659), on sig. a2v in the preface. See Anstey, *The Philosophy of Robert Boyle*, London and New York: Routledge (2000), p.12 note 2.

never have learned the 'true Physical Causes' of 'the Ascension of Water in Pumps', for example, 'if the Moderns had acquiesced, as their Predecessors did, in that imaginary one, that the World was Govern'd by a Watchful Being, call'd Nature, and that she abhors a vacuum, and consequently is still in a readiness, to do irresistibly whatever is necessary to prevent it'. Such 'veneration, where-with Men are imbued for what they call Nature', Boyle added, 'has been a discouraging impediment to the Empire of Man over the inferior Creatures of God'.⁶⁴

Boyle's advocacy of the mechanical philosophy had definite implications for his philosophy of science, especially his view of what constitutes a legitimate scientific explanation. Above all, he argued, one ought not to invoke divine omnipotence in natural philosophy. What he wrote against the Jesuit philosopher Francis Line is instructive here. In trying to explain the expansion of fixed quantities of air without employing void spaces between atoms, Line had proposed that God could give atoms a 'virtual extension', causing the atoms to expand and fill thousands of times more space without creating empty spaces between them. Thereby he believed he could preserve the Aristotelian principle that 'nature abhors a vacuum'. Such a thing was possible by God's absolute power, Line argued, and therefore it had to be consistent with the nature of matter. '[N]one is more willing to *acknowledge* and *venerate* Divine Omnipotence' than I am, Boyle replied. He continued as follows:

But, not now to dispute of a power that I am more willing to adore then question, I say, that our Controversie is not what God can do, but about what can be done by *Natural Agents*, not elevated above the sphere of Nature. For though *God* can both create and annihilate, yet *Nature* can do neither: and in the judgment of true Philosophers I suppose our *Hypothesis* would need no other advantage to make it be preferred before our Adversaries, then that in ours things are explicated by the ordinary course of Nature, whereas in the other recourse must be had to miracles.⁶⁵

Beyond this, proper explanations ought to be suited to particular phenomena, ought to declare what causes a thing and how it does so, ought to tell us the means and process that produce an effect, and ought to focus on mechanical means, not immaterial agents.⁶⁶ If I might here single out just the final point for further comment, I illustrate it by quoting from his critique of Aris-

64 Boyle, R. *Notion of Nature*, Works X, p. 450.

65 Boyle, R. *Defence Against Linus*, Works III, p. 48. Wojcik likewise emphasises this aspect of Boyle's natural philosophy, using the same passage to make the point; see Wojcik, *op. cit.*, [35], pp. 162-163.

66 These points are discussed in Boyle, R. *Forms and Qualities*, Works V, p. 393; Boyle, R. *Mechanical Qualities*, Works VIII, pp. 397 and 416-417; Boyle, R. *Notion of Nature*, Works X, p. 558; Boyle, R. *Excellency and Grounds of the Mechanical Hypothesis*, Works VIII, pp. 108-114; and Boyle, R. *Final Causes*, Works XI, p. 150. For illuminating studies of Boyle's philosophy of science, see Wojcik, *op. cit.* [35], pp. 151-188, and Sargent, R.M. *The Diffident Naturalist: Robert Boyle and the Philosophy of Experiment*, Chicago: University of Chicago Press (1995), esp. pp. 98-108 and 122-128.

totelian forms and qualities. These immaterial concepts were said to explain how the physical properties of bodies were produced. For example, why does snow dazzle the eyes more than grass? Here is Boyle's opinion of the traditional Aristotelian answer:

to say, that these and the like Effects are perform'd by the substantial Forms of the respective Bodies, is at best but to tell me, what is the Agent, not how the Effect is wrought; and seems to be but such a kind of general way of answering, as leaves the curious Enquirer as much to seek for the *causes* and *manner* of particular Things, as Men commonly are for the particular causes of the several strang Things perform'd by Witchcraft, though they be told, that tis some Divel that does them all.⁶⁷

The devil, it seems, was *not* to be found in the details.

In keeping with his view that the mechanical philosophy was a powerful ally for religion, Boyle was an outspoken advocate of the design argument. Indeed he had a very strong interest in apologetics generally, reflecting the lifelong conversation he had with his own religious doubts. He wrote extensively on apologetic themes, and in a part of his will that may reflect the influence of Burnet he established a lectureship for 'proveing the Christian Religion against notorious Infidels (viz.) Atheists, Theists [that is, deists], Pagans, Jews and Mahometans, not descending lower to any Controversies that are among Christians themselves'.⁶⁸ Although he often targeted 'atheists' in his writings, he realised that genuine philosophical atheism was rare in his day. His real targets were the lust, greed, vanity and open mockery of the Bible exhibited by courtiers and self styled literary 'wits', the type of people whom he once called 'practical Atheists', those 'baptised infidels' who lived as if there were no God to judge them – and here he thought the design argument had its greatest value.⁶⁹ As he stated in *A Disquisition about the Final Causes of Natural Things*, he desired 'that my Reader should not barely observe the Wisdom of God, but be in some measure Affectively Convinc'd of it'. There was no better way, in Boyle's opinion, to 'give us so great a Wonder and Veneration for it', than 'by Knowing and Considering the Admirable Contrivance of the Particular Productions of that Immense Wisdom', by which he mainly meant the exquisitely fashioned parts of animals both great and small. Thereby, Boyle believed, 'Men may be brought, upon the same account, both to *acknowledge* God, to *admire* Him, and to *thank* Him'.⁷⁰ By detailing the intricate constructions of marvellous creatures, science called attention to the creator in a manner that could not be equalled by other means.

67 Boyle, R. *Forms and Qualities*, Works V, p. 352.

68 The relevant part of Boyle's will is printed in Maddison, *op. cit.*, [58], p. 274. On Burnet's possible role, see Hunter, M. (ed.), *op. cit.* [6], pp. xxiv-xxv and the accompanying note.

69 Boyle, R. *Christian Virtuoso, II*, Works XII, p. 482. The term 'practical Atheists', found in a manuscript version, is not found in the published version of this posthumous work, which Henry Miles compiled from Boyle's papers in the early 1740s.

70 Boyle, R. *Final Causes*, Works XI, pp. 145 and 95.

For reasons such as these, Boyle unhesitatingly described himself as a ‘*priest of nature*.’⁷¹ It was ‘an act of Piety to offer up for the Creatures the Sacrifice of Praise to the Creator; for, as anciently among the Jews, by virtue of an Aaronical Extraction, Men were born with a Right to Priesthood; so Reason is a Natural Dignity, and Knowledge a Prerogative, that can confer a Priesthood without Uncion or Imposition of Hands.’⁷² God wanted us ‘to have his Works regarded & taken Notice of’, Boyle emphasised. From this he inferred that ‘the study of the Booke of Nature, is one of the Ends of the Institution of the Sabbath’, adding that ‘I scruple not (when Opportunity invites) to spend some [time on the Sabbath] in Studying the Booke of the Creatures, either by instructing my selfe in the Theory of Nature; or trying those Experiments, that may improve my Acquaintance with her.’⁷³ On at least one occasion, Boyle even had his servants help him with an experiment on Sunday, when circumstances seemed to require it.⁷⁴ This would have been a rare exception, however, judging from a laboratory notebook covering the entire period from December 1684 to June 1688, in which the list of ‘Experiments done’ scrupulously omits Sundays from the calendar.⁷⁵

As we have seen, Boyle found the mechanical philosophy attractive for two nearly opposite reasons. On the one hand, it drew our attention away from nature itself, pointing clearly and powerfully to the One who had fashioned it so exquisitely, the proper object of our worship. On the other hand, it drew our attention more deeply into nature, by stressing the created mechanisms themselves as the proper subjects of our investigations. Thus, Boyle argued that final causes had a proper place within natural philosophy, with a crucial caveat: ‘*That the Naturalist should not suffer the Search or the Discovery of a Final Cause of Nature’s Works, to make him Undervalue or Neglect the studious Indagation of their Efficient Causes*’. To neglect efficient causes ‘would render Physiology Useless: But the studious Indagation of them, will not Prejudice the Contemplation of *Final Causes*’. Indeed, ‘the Wise Author of Nature has so excellently Contriv’d the Universe, that the more Clearly and Particularly we Discern, how Congruous the Means are to the Ends to be obtain’d by them, the more Plainly we Discern the Admirable Wisdom of the Omniscent Author of Things; of whom it is Truly said by a Prophet, that *He is Wonderful in Counsel, and Excellent in Working*.’ Learning the ‘Intermediate Causes’ did not remove the need ‘to admit a First and Supreme Cause’, since ‘That Order of Things, by vertue of which these Means become sufficient to such Ends, must have been at first Instituted by an Intelligent Cause.’ Neither the present ‘Fabrick of the Universe’ nor the ‘*First Formation*’ of the Universe’ could rationally be ascribed to ‘so Blind a Cause as *Chance*’.⁷⁶ Throughout his voluminous writings, Boyle

71 Boyle, R. *Christian Virtuoso*, II, Works XII, p. 490.

72 Boyle, R. *Usefulness of Natural Philosophy*, I, Works III, p. 203.

73 Boyle, R. ‘Of the Study of the Book of Nature’, Works XIII, pp. 154-155.

74 Boyle, R. ‘New Experiments Concerning Light and Air’, Works VI, p. 18.

75 Royal Society, Manuscript 190, fols. 170v-167.

76 Boyle, R. *Final Causes*, Works XI, pp. 149-151, quoting Isa. 28:29.

insisted that intelligence be invoked as a principle of world-formation; the appeal to 'chance' or 'nature' alone without God guiding the parts of matter was religiously dangerous. He loved to cite the pre-Socratic philosopher Anaxagoras as an example of a mechanical philosopher with similar views, since Anaxagoras saw nature as a 'cosmos' rather than a 'chaos' owing to the formative influence of an immaterial $\nu\omicron\upsilon\varsigma$ (mind). In an important unpublished 'Post-script' to his treatise on the *Notion of Nature*, Boyle even coined the term 'Anaxagorean' philosopher to set himself apart from the 'Epicurean & such like Attomists who after Leucippus & Democritus ascribe not only the particular effects produc'd in the world but the first formation of the world it selfe to the casual concourse of indivissible Corpuscles of Uncreated Matter moveing from all Eternity in an in infinite [sic] empty space without takeing in any Diety or other incorporeal substance to sett these Attomes a moveing or regulate their Motions'.⁷⁷

Perhaps to make sure that no one had somehow missed it, Boyle restated his position on natural theology one more time in his final theological work, *The Christian Virtuoso*, part of which was published several decades after his death. The rest of its full title nicely encapsulates his own understanding of his vocation: 'SHEWING, That by being addicted to *Experimental Philosophy*, a Man is rather Assisted, than Indisposed, to be a *Good Christian*'. He also introduced a new line of thinking, elegantly linking the character of the Christian virtuoso with the actual practice of science. The Christian virtuoso, said Boyle, was to be known for personal honour and trustworthiness; devotion to one's work as a divinely ordained vocation, even a religious duty; and reliance on the testimony of nature, not human opinion. Also, the virtuoso ought to place the pursuit of truth over personal gain and sensual pleasure, openness and generosity over secrecy.⁷⁸

Here we must frankly imitate Boyle's usual honesty to his own fault: although much of what he did is consistent with these norms, he nevertheless carefully guarded the various alchemical secrets that he acquired (sometimes for a price), even to the extent of encoding chemical terms to ensure that his assistants would not be able to pass on the secrets. He also sometimes claimed as his own, processes he had learned from others, particularly the American alchemist George Starkey, who helped initiate Boyle into laboratory work in the early 1650s. To be fair, alchemy was always considered a highly secretive enterprise, and alchemists unashamedly borrowed liberally from one another without acknowledgment. Yet not many years afterward, Boyle himself began

77 The 'Post-script' is found in *Works* XIV, pp. 147-157, quoting 148. Michael Hunter and I discuss its content, context, and significance in 'The Making of Robert Boyle's *Free Enquiry into the Vulgarly Receiv'd Notion of Nature* (1686)', *Early Science and Medicine* (1996) 1, 204-271.

78 Here I follow the analysis of Shapin, S. 'Who was Robert Hooke?', In Hunter, M., Schaffer, S. (eds.) *Robert Hooke: New Studies*, Woodbridge, Suffolk: The Boydell Press (1989), pp. 253-285, (p. 269-272).

self-consciously and even somewhat self-righteously to insist on the importance of intellectual property, and his usual practice at the height of his career was carefully to cite sources. William Newman and Lawrence Principe have suggested plausibly that the ‘dissonance between Boyle’s words on intellectual property and his actions in regard to his chymical forebears’ can be explained by the fact that Boyle ‘wished to deploy chymistry in the service of natural philosophy and to free it from its ambiguous reputation, emphasizing that this was a fresh start for chymistry. In this regard, linking himself publicly to pre-existing traditions would be counterproductive.’⁷⁹ Whatever the reason, apart from his extensive involvement with the alchemical tradition, Boyle does seem to have honoured religiously his own standard of openness and honesty in scientific communication.

Above all, Boyle believed that the Christian virtuoso benefited from the hard work of explicating natural phenomena, which ‘does insensibly work in him a great and ingenuous *Modesty of Mind*’.⁸⁰ The cultivation of humility was vital, since ‘the higher degree of knowledge’ that the scientist attains ‘seems more likely to puff him up, than to make him humble’.⁸¹ It is not that he sought no credit for his own discoveries – like most scientists of any era, he wanted his fair and appropriate share – it is rather that he wanted all scientists ‘to mind more the Advancement of Natural Philosophy than that of their own Reputations’.⁸² The experimental life itself was conducive to modesty. As he said at the end of a lengthy and detailed description of inconclusive experiments about bubbles in ice, ‘I shall not think I have altogether mis-spent my time, especially if so many past Experiments, both new, and not altogether impertinent, by their not having taught us enough about so despicable a subject as a Bubble, shall, as they justly may[,] teach us Humility.’⁸³

Robert Boyle died in his sister’s house shortly after midnight on the final day of 1691. She had died herself just eight days before, and it is probably true that grief hastened his passing, although he was never robust and had been in declining health for several years. Laid to rest close to her in the chancel of their parish church, St Martin-in-the-Fields, the precise location of his grave is no longer known. The humility suggested by this fate is entirely fitting to the character of one of the greatest scientists who has ever lived.

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79 Principe, *The Aspiring Adept: Robert Boyle and His Alchemical Quest*, Princeton: Princeton University Press (1998), esp. pp. 143-153; Newman and Principe, *Alchemy Tried in the Fire: Starkey, Boyle, and the Fate of Helmontian Chymistry*, Chicago: University of Chicago Press (2002), pp. 22-34 and 266-272, quoting pp. 32-33.

80 Boyle, R. *Christian Virtuoso, I*, Works XI, p. 322.

81 Boyle, R. *Christian Virtuoso, II*, Works XII, p. 490.

82 Boyle, R. *Certain Physiological Essays*, Works II, p. 13-14.

83 Boyle, R. *Cold*, Works IV, p. 319.