"The Light of Nature": God and natural philosophy in Isaac Newton's *Opticks*

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> Blessed are your eyes, for they see.
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> Matthew 13:16

> We see the effects of a Deity in the creation and thence gather the cause and therefore the proof of a Deity and what are his properties belongs to experimental Philosophy. Tis the business of this Philosophy to argue from the effects to their causes till we come at the first cause.
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> Isaac Newton (*c*. 1705)[1]

God in the *Opticks*: afterthought or continuing presence?

When Newton first published his *Opticks* in 1704 he was releasing a work that contained neither direct references to God nor any explicit statement of natural theology. As such, the first edition of Newton's second great work would have appeared even more secular than the first edition of the *Principia*, which included a single mention of God and natural theology along with one mention of the Scriptures.[2] But just as Newton went on to expand on his commitments to natural theology in the second edition of the *Principia* in 1713, so he added natural theological material to the next edition of the *Opticks*, the Latin *Optice* of 1706. Nevertheless, the greater presence of God and natural theology in the later editions of both works has led some observers to conclude that theological commitments sit lightly on the core natural philosophical content or "essence" of the two books. On

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[1]Isaac Newton, Cambridge University Library MS. Add. 3970 (B), f. 619v. For permission to quote from manuscripts in their archives, I am grateful to the Syndics of the Cambridge University Library, the Jewish National and University Library, Jerusalem and the Provost and Fellows of King's College, Cambridge. Deletions in the original manuscripts have been eliminated.

[2]On this, see I. Bernard Cohen, "Isaac Newton's *Principia*, the Scriptures, and the divine providence", *Philosophy, science, and method*, ed. Sidney Morgenbesser, et al. (New York: St. Martin's Press, 1969), pp. 523-48.

this reading, the overt references to God and the elaborate treatments of natural theology in the later editions suggest that this material plays a largely rhetorical role, providing a *post facto* theological justification for a pure "science" that has little to do with fundamental commitments to belief in God and design. Despite the *prima facie* plausibility of this reading, it is now known that Newton had been developing a profoundly theological understanding of nature and its phenomena long before 1704. This included not only a belief that God created the world and continues to sustain it, but a conviction that natural philosophy, when practised correctly, would led inductively to a belief in God and design. Seen in this light, some of the statements in the *Opticks* supportive of an inductive approach to the study of nature take on a different hue.

At its most extreme, the first argument reveals ahistorical essentialism and implies a rational reconstructionist assumption that pre-modern natural philosophy was ultimately a secular enterprise. While no leading Newton scholar has presented such an unsophisticated and myopic argument in print, some have ventured close. Other scholars less familiar with Newton have gone further. Thus, Medievalist Edward Grant has recently characterised the General Scholium to the *Principia*, with its powerful theological focus, as little more than an afterthought to the mathematical physics of the main body of the work. For natural philosophers like Newton, Grant avers, "God may lie in the background as Creator, or perhaps simply as inspiration, but He does not enter into the content of their works, or affect it, because that would have proved futile".[3] In fairness, it is possible that Grant may have been unaware of the wealth of theological manuscripts that show the intimate relation between Newton's natural philosophy and his religion.

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[3]Grant, "God and natural philosophy: the late Middle Ages and Sir Isaac Newton", *Early Science and Medicine* 5 (2000): 288-91 (citation from p. 291).

This cannot be said of I. Bernard Cohen. Although his admirable 1969 paper on the backdrop to the two theological references in the first edition to the *Principia* reveals in great detail that theology was present in all three editions of the book, Cohen concludes this same study by asserting that these examples "may serve as a continual reminder of how great the temptation always was for Newton to stray from the strict and narrow path of science and to meander through theological metaphysics".[4] Three decades later, in his introductory guide to the new translation of the *Principia* he produced with Anne Whitman, Cohen revisited the temptation theme. Although he acknowledged that Newton from "time to time" mused about the inclusion in his great work of "some extracts from ancient sages and philosophers or other hints of his fundamental and all-encompassing concerns . . . in the end, he resisted the temptation to 'show his hand,' and the *Principia* remained an austere presentation of mathematical principles and their applications to natural philosophy".[5] Once again, Cohen sets up a struggle experienced by the "real" Newton the "scientist" who is constantly fighting the temptation to sully his mathematical physics and optics with alchemical and theological concerns that are fundamentally foreign to these studies.

Three years later, in his introduction to the *Cambridge companion to Newton*, Cohen is careful to acknowledge that "Newton seems to have believed that there was a unity in all the areas he explored: the interpretation of the Bible, the tradition of ancient wisdom, Church history, alchemy, prophecy, optics and color theory, theory of matter, rational mechanics, and celestial dynamics".[6] Yet to this he quickly adds:

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[4]Cohen, "Isaac Newton's *Principia*, the Scriptures, and the divine providence," p. 533.

[5]Cohen, "A guide to Newton's *Principia*", in Isaac Newton, *The Principia: Mathematical principles of natural philosophy, a new translation by I. Bernard Cohen and Anne Whitman, assisted by Julia Budenz* (Berkeley: University of California Press, 1999), p. 60.

[6]Cohen, "Introduction", *The Cambridge companion to Newton*, ed. I Bernard Cohen and George E. Smith (Cambridge: Cambridge University Press, 2002), p. 28.

> But it is a fact of record that in his writings on mathematics, in the *Principia*, and in his writing about optics proper, there was no trace of his concern for these esoteric subjects. Only in the later Queries to the *Opticks* do we find a hint of his concern for alchemy, in that part of the queries where he speculates about the structure of matter. In short, these esoteric subjects were not features of the known thought of the public Newton or the Newton of history, the Newton who has been so important a figure in modern thought.[7]

It is hard to imagine how a scholar with such a close familiarity with both the published and unpublished works of Newton could make such astounding claims. Virtually every statement in this conclusion can be challenged—in part using some of Cohen's own excellent historical work. Given that Cohen had just admitted that Newton himself saw wider connections in his thought, these claims sound especially shrill. Not only is the insinuation that there is some sort of metaphysical distinction between Newton's public and private writings contradicted by what we now know about the tight, albeit complex, relationship between his more open private texts and his more cautious public productions, but as the General Scholium to the *Principia* and Queries 28 and 31 to the *Opticks* demonstrate, it is misleading to imply that none of Newton's private thoughts on religion were released in the public sphere. Cohen's affirmation that he is most concerned with "the Newton who has been so important a figure in modern thought" is also revealing. His Newton is the Newton created through three centuries of myth-making that has depended on the selective use of the available evidence. This Newton is in part a construction that historians of science ought to be dismantling.

Similar arguments have been presented by A. Rupert Hall who, like Cohen, has produced excellent work of lasting importance on Newton's natural philosophy. Near the end of his biography of Newton, Hall argues that the first editions of both the *Principia* and the *Opticks* say almost

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[7]Cohen, "Introduction", *Cambridge companion to Newton*, pp. 28-29.

nothing about the religion of their author. In Hall's view, "Newton did not at first rest his natural philosophy upon any declared metaphysical or religious foundations", but instead "was satisfied to start from physical axioms, exploring Nature by experiment and mathematical analysis". However, with "advanced age", starting with the Latin *Optice* of 1706, the great natural philosopher began "to inject into his scientific writings his system of natural theology".[8] This claim is misleading in several ways. First, it is hard to imagine that a dramatic change in Newton's outlook and abilities could have taken place in the short two-year interval between the publications of the first English and Latin editions of the *Opticks*. There are echoes in Hall's statement of the old trope that Newton only turned to theology when his mind was weakened with age, when in fact the manuscript evidence decisively proves that Newton was engaged in a massive study of theology, prophecy and church history both during the decade before he began to write the *Principia* and during the years in which he composed it. Hall's statement also implies an essentialism in which there was in Newton's age an entity called "science" into which theology or natural theology would be a foreign intrusion. Similarly, we can also put to one side the historical anachronism implied in the characterisation of Newton's *Principia* and *Opticks* as "scientific writings" (a characterisation that may be at the root of the problem).

Hall's assertion that "Newton did not at first rest his natural philosophy upon any declared metaphysical or religious foundations" is misleading in other ways as well. The implication that Newton only crafted a theological gloss to his natural philosophical works is directly contradicted by the documentary evidence, which shows integration between theology and natural philosophy in Newton's writings well before 1706. In fact, the earliest signs of this integrationist thinking date to

[8]Hall, *Isaac Newton: adventurer in thought* (Oxford: Blackwell, 1992), p. 375.

his undergraduate notebook of the mid-1660s.[9] But it was not merely integration that Newton sought. It was Newton's firm belief that his natural philosophical method would lead to the conclusion that the universe was the product of God's creation. It is now evident that from his early discomfort with the putative atheistic tendencies of Cartesianism shown in *De gravitatione*,[10] Newton was also attempting to construct a natural philosophy that was inextricably associated with God. This attempt began long before the *Opticks* first appeared in print. This is a Newton who is far from the mythology of the positivists. Hall goes on in his biography to make the claim that the natural theological material in the later editions of the *Principia* and the *Opticks* should be viewed as rationalisations superadded after the fact:

> In day-to-day, week-to-week terms the pursuit of genius and the search for God could never proceed simultaneously along identical lines, however devout the natural philosopher. And however clearly Newton's notebooks may prefigure a godly outlook upon knowledge, the mature formulation of his natural theology in print can only be judged a *post facto* rationalization of his career of scientific investigation.[11]

Thus, once again, the natural theology and theology proper can be dismissed as having no formative, motivational or cognitive relationship to Newton's natural philosophy. It is hard to resist the conclusion that Hall is trying to shape Newton into the image of a modern, secular scientist instead of attempting to understand Newton in his own terms.

Using the example of the *Opticks*, I will challenge these readings of Newton in this paper.[12]

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[9]On this, see Snobelen, "'The true frame of Nature': Isaac Newton, heresy and the reformation of natural philosophy", in *Science and heterodoxy*, ed. John Hedley Brooke and Ian Maclean, Oxford University Press, forthcoming.

[10]Newton began to move away from Cartesianism by the time he composed his *De gravitatione* partly because of his growing belief that Descartes' philosophy it inclined to atheism (*cf.* Westfall, *Never at rest: a biography of Isaac Newton* [Cambridge: Cambridge University Press, 1980], p. 648).

[11]Hall, *Isaac Newton*, p. 376.

[12]I elsewhere study the example of the theological backdrop to the *Principia*. See Snobelen, "'God of Gods, and Lord of Lords': the theology of Isaac Newton's General Scholium to the *Principia*", *Osiris* 16 (2001): 169-208.

First, I examine evidence that shows that Newton contemplated an explicit statement of natural theology for the first edition of the *Opticks*. Then I discuss the natural theological material added to the 1706 *Optice*. In doing so, I note examples of its relation to statements made in the General Scholium to the *Principia*, demonstrate how it is illuminated by the more explicit statements made in a draft of Query 23 (31) and explore connections between the public statements of the Queries and more explicit material on natural theology in Newton's private manuscripts. Next I show that, as in the General Scholium, the material added in the later editions of the *Opticks* also includes clues about his heretical antitrinitarian theology. Finally, I suggest ways in which Newton's commitments to natural theology and a powerful unitarian God of dominion helped to underpin his natural philosophy. In sum, this paper contends that both Newton's natural theology and his heretical theology relate to the natural philosophy of the *Opticks* in ways that are much more fundamental than a thin veneer of rhetoric. This paper is based not only on an analysis of the published texts, but also of *Opticks*-related drafts and other textual parallels in Newton's unpublished writings. These private manuscripts will help to open a window on the intended meaning of Newton's public texts.

The first edition of the *Opticks* and the "Principles of philosophy"

Although the *Opticks* was not published until the spring of 1704, when its author was beginning his seventh decade, its contents had a prehistory that dated back to the early 1670s, when Newton was a young man in his late twenties and early thirties. During this long gestation period Newton developed the principles of optics that contributed to his fame. Substantial portions of the work were based on his Lucasian lectures on optics delivered from 1670 to 1672 and two papers he sent to the Royal Society in 1675. The bulk of its formal composition, using additional experimentation and

new material, dates to two periods after the publication of the *Principia*: 1687 (or 1687 to early 1688) and 1691 to 1692.[13] David Gregory saw the incomplete drafts of the three books of the *Opticks* in 1694 and recorded that Newton intended to publish them "within five years after retiring from the University". Gregory also mentions the possibility that the work might be translated into Latin, if published while Newton was still at Cambridge.[14] Aside from these apparent projections by the author, it is difficult to resist the conclusion that the continued existence of Newton's enemy Robert Hooke, who had first challenged Newton's optical work in 1670s, had something to do with the timing of the publication. It may not be a coincidence that Newton only committed himself to publication when Hooke was incapacitated during his final months. When Hooke died on 3 March 1703 the most painful thorn in his side was removed.[15] Newton himself claimed in the Advertisement to the edition of 1704 that his reason for delaying publication was "[*t*]*o avoid being engaged in Disputes*" about optical theory.[16] Many are familiar with some of the main features of the contents of this work, including Newton's explication of the heterogeneous nature of light, the *experimentum crucis*, the corpuscularian theory of light, the physiology of the eye, the description of the first working reflecting telescope, the discussion of the seven colours of the rainbow, Newton's rings and the emphasis on induction and experiment. Few are familiar with some of the other agendas he had for the book.

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[13]For background on the composition of the *Opticks*, see Alan E. Shapiro, "Beyond the dating game: watermark clusters and the composition of Newton's *Opticks*", *The investigation of difficult things: essays on Newton and the history of the exact sciences in honour of D.T. Whiteside*, ed. P.M. Harman and Alan E. Shapiro (Cambridge: Cambridge University Press, 1992), pp. 181-227 and A. Rupert Hall, *All was light: an introduction to Newton's Opticks* (Oxford: Clarendon Press, 1993) pp. 33-91.

[14]Gregory, Memoranda from 5, 6 and 7 May 1694, in Newton, *The correspondence of Isaac Newton*, ed. H.W. Turnbull (Cambridge: Cambridge University Press, 1961), 3: 338-9 (quotation from p. 339).

[15]*Cf.* E.T. Whittaker, "Introduction", in Newton, *Opticks or a treatise of the reflections, refractions, inflections & colours of light*, 4th ed. (New York: Dover, 1952), p. lxxvii and Hall, *All was light*, p. 92.

[16]Newton, Advertisement, *Opticks: or, a treatise of the reflexions, refractions, inflexions and colours of light* (London, 1704).

Light is shed on some of these agendas in a preface Newton drafted for the first edition, but in the end never published. This draft preface to the *Opticks*, identified as such by J.E. McGuire and dated by him to the years between 1700 and 1704, commences with a powerful endorsement of the effectiveness of inductivism and experiment and then goes on to outline four key "principles of philosophy".[17] A paragraph is devoted to inductivism and each of the four principles. In order of appearance, these principles are "the being of a God or Spirit infinite, eternal, omniscient, omnipotent"; "that matter is impenetrable by other matter"; "that all the great bodies in the Universe have a tendency towards one another proportional to the quantity of matter contained in them"; and "that all bodies are aggregated of particles laid together with many interstices or pores between them". Of the five paragraphs, it is the first and second on inductivism and God that are of greatest concern to us in this paper.

Newton begins Part I of the first book of the *Opticks* with a bold statement: "My Design in this Book is not to explain the Properties of Light by Hypotheses, but to propose and prove them by Reason and Experiments". With this statement of programme, Newton establishes his vision for experimental philosophy. As confident as this opening statement is, Newton's draft preface shows that he was even more enthusiastic about the potential for the inductive approach than he indicated in the first edition. Newton begins the draft preface with an attack on the reckless use of hypotheses by natural philosophers. Using language that is much more apologetic than that used at the head of

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[17]McGuire, "Newton's 'Principles of philosophy': an intended preface for the 1704 *Opticks* and a related draft fragment", *The British Journal for the History of Science* 5 (1970): 178-86. Among the lines of evidence McGuire uses to conclude that this treatise was considered for inclusion in the *Opticks* is a statement near its conclusion where Newton speaks about using a principle "in the following treatise [to] give an account of the permanent colours of natural bodies" (p. 184). McGuire has given the untitled document the title "Principles of philosophy". McGuire provides a full transcription of the draft preface and the related fragment. In my quotations from these transcriptions, I have corrected them against the original and have omitted words cancelled by Newton.

the published edition, Newton asks: "what certainty can there be in a Philosophy which consists in as many Hypotheses as there are Phenomena to be explained?". In what is almost certainly a slight against Descartes,[18] Newton adds:

> To explain all nature is too difficult a task for any one man or even for any one age. Tis much better to do a little with certainty and leave the rest for others that come after; than to explain all things by conjecture without making sure of any thing. And there is no other way of doing any thing with certainty than by drawing conclusions from experiments and phaenomena until you come at general Principles and then from those Principles giving an account of Nature. Whatever is certain in Philosophy is owing to this method and nothing can be done without it.[19]

Explanation by conjecture is not the way forward. Instead, the natural philosopher must induce general principles from the specifics revealed in experiment and observation. These natural philosophical apologetics would be echoed in the later Queries to the *Opticks* and the General Scholium to the *Principia*.[20]

Immediately after this statement, Newton turns to his first "principle of philosophy". He wastes no time in getting to the heart of the matter: "One principle in Philosophy is the being of a God or Spirit infinite, eternal, omniscient, omnipotent, and the best argument for such a being is the frame of nature and chiefly the contrivance of the bodies of living creatures".[21] The language used of God here resonates with the descriptions and titles of God in the General Scholium of 1713 and 1726, where Newton speaks of God as "the lord of all", "Lord God *Pantokrator* [Almighty]",

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[18]McGuire concludes that "Newton probably had in mind Descartes, the Cartesians and Charleton, all of whom tended to relate, in a direct way, the qualities of internal 'explanatory mechanisms' to the observable properties of phenomena" (McGuire, "Newton's 'Principles of philosophy'", p. 183 n. 18.

[19]Newton in McGuire, "Newton's 'Principles of philosophy'", p. 183.

[20]In the associated fragment, Newton provides an early example of his opposition to "feigning" hypotheses, an opposition immortalised in the expression "*hypotheses non fingo*" of the General Scholium: "if without deriving the properties of things from Phaenomena you feign Hypotheses and think by them to explain all nature you may make a plausible systeme of Philosophy for getting your self a name, but your system will be little better than a Romance" (Newton in McGuire, "Newton's 'Principles of philosophy'", p. 185).

[21]Newton in McGuire, "Newton's 'Principles of philosophy'", p. 183.

"universal ruler" and "eternal and infinite, omnipotent and omniscient".[22] But the description of an eternal omniscient and all-powerful God also matches the language Newton used of God in his private theological papers. In the opening words of his Twelve Statements on God and Christ, which dates from the early eighteenth century, Newton states: "There is one God the Father everliving, omnipresent, omniscient, almighty, the maker of heaven & earth".[23] In Newton's heretical antitrinitarian theology, only the Father deserved such titles. Similarly, in his "A short Scheme of the true Religion" Newton writes: "We are therefore to acknowledge one God infinite eternal omnipresent, omniscient omnipotent, the creator of all things most wise, most just, most good most holy, and to have no other Gods but him".[24] Thus, had he published the "Principles of philosophy" with his *Opticks* in 1704, Newton would have been releasing to the literate world a description of God that derived from his private theology. As we will see, he does this very thing two short years later.

In the second half of the opening line of the first "principle of philosophy" Newton reveals his belief that the structure of the universe and the design of living creatures infer the existence of God—a deity with the qualities and attributes he has just described. He refers first to the evident symmetry in the physiological structure of animals:

> All the great land animals have two eyes in the forehead, a nose between them a mouth under the nose, two ears on the sides of the head, two arms or two forelegs or two wings on the shoulders and two legs behind and this symmetry in the several species could not proceed from chance there being an equal chance for one eye or for three or four eyes as for two, and so of the other members.[25]

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[22]Newton, *Principia*, pp. 940-941.

[23]Newton, King's College, Cambridge, Keynes MS 8. Newton had first written "eternal" before replacing it with the word "everliving".

[24]Newton, Keynes MS 7, p. 2. Newton had initially written "the supreme God" before replacing it with the expression "one God".

[25]Newton in McGuire, "Newton's 'Principles of philosophy'", p. 183.

For Newton, this symmetry inferred a single creator with a unified purpose rather than the emergence of these bilateral structures through pure chance-based mechanisms (here Newton may have been thinking of the teachings of Epicureanism). Newton also sees evidence of wisdom at work in the functional features of animals and birds:

> Nothing is more curious and difficult than the frame of the eyes for seeing and of the ears for hearing and yet no sort of creatures has these members to no purpose. What more difficult than to fly? and yet was it by chance that all creatures can fly which have wings?[26]

Not only do these features reveal impressive structural design in and for themselves, Newton contends, but they were created to work effectively in the environments in which creatures live:

> Certainly he that framed the eyes of all creatures understood the nature of light and vision he that framed their ears understood the nature of sounds and hearing, he that framed their noses understood the nature of odours and smelling, he that framed the wings of flying creatures and the fins of fishes understood the force of air and water and what members were requisite to enable creatures to fly and swim: and therefore the first formation of every species of creatures must be ascribed to an intelligent being.[27]

Thus, Newton reasons, there must be "an intelligent being" who is both a perfect mechanic and who has perfect understanding of the phenomena and media of the wider world: light, sound, water and air. Birds are structured the way they are because God understood the nature of the resistance of air. The structure of the fish is explained by the fact that God also understood fluid dynamics. The unity of God explains the unity of nature. The fullness of the Creator's presence and intelligence is tied to the interconnectedness and universality of natural phenomena. Here the inference is that only a single, omnipresent and omniscient God could have created everything.

After outlining these arguments for the existence of God—not just any god but a single God

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[26]Newton in McGuire, "Newton's 'Principles of philosophy'", p. 183.
[27]Newton in McGuire, "Newton's 'Principles of philosophy'", p. 183.

who is all-knowing and everywhere present—Newton concludes his account of the first "principle of philosophy" with an expostulation that is at once revealed and saturated in theological apologetics:

> These and such like considerations are the most convincing arguments for such a being and have convinced mankind in all ages that the world and all the species of things therein were originally framed by his power and wisdom. And to lay aside this argument is unphilosophical.[28]

In this concluding statement Newton appeals to reason and history to assert that his arguments are only those that have all along prevailed with mankind. But the sub-text also implies that Newton believed that those who did not accept these arguments were not only condemned by history, but were also unphilosophical in their thinking—a particularly strong judgment coming from Newton. Conversely, the implication is that the approach he has outlined can be described as philosophical. It is also noteworthy that the arguments in this paragraph are based on induction derived from observation, the very method he champions in the first paragraph of the "Principles of philosophy". No less significant is Newton's claim that the existence of God is a principle of philosophy, even perhaps the first principle of philosophy. This claim echoes one he made a decade or more earlier in his writings on the original religion. When proposing that ancient temples were meant to model the universe or "the frame of nature", he wrote the following:

> ... twas one designe of the first institution of the true religion to propose to mankind by the frame of the ancient Temples, the study of the frame of the world as the true Temple of the great God they worshipped. And thence it was that the Priests anciently were above other men well skilled in the knowledge of the true frame of Nature and accounted it a great part of their Theology.[29]

Given the tenor of Newton's thought, it is all but certain that Newton saw the dual theological-philosophical role of the ancient priests as prescriptive for his own age. It also seems likely that he

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[28]Newton in McGuire, "Newton's 'Principles of philosophy'", p. 183.
[29]Isaac Newton, Jewish National and University Library, Jerusalem, Yahuda MS 41, f. 7r.

thought in terms of a disciplinary framework within which theology was bound up with natural philosophy. Roughly a decade after penning his "Principles of philosophy", he again spoke about a relationship between theology and natural philosophy. This time, in a work on mathematical physics, he grants priority to natural philosophy, concluding the theological portion of the General Scholium with the declaration that "to treat of God from phenomena is certainly a part of experimental philosophy".[30]

Why Newton chose not to include this draft preface is difficult to determine. He may have thought it too bold or perhaps too imperfect and incomplete. He may have thought the time was not yet right to make these arguments explicit. He may have merely been exhibiting his usual caution. Whatever the reason, that fact that he wrote it, and that he did publish similar conclusions in later editions of the *Opticks*, not to mention the General Scholium, demonstrates that we can be sure that his reason for suppressing the document was not because he believed it had nothing to do with his natural philosophy. And, in his declaration that God is a principle of philosophy, we see how far removed Newton was from later positivistic portrayals of him. Clearly, there is more in the *Opticks* than first meets the eye.

Natural theology and the assault on atheism in Query 28

While Newton would wait twenty-six years before making the theological corollaries to his *Principia* explicit, a mere two years would pass before he did the same for the *Opticks*. If he had any hopes of reaching the Continent with the content of his *Opticks*, a Latin edition was essential. In 1706 this

[30]Newton, *Principia*, p. 943. In the third (1726) edition of the *Principia*, Newton replaced "experimental" with "natural", thus broadening his claim.

appeared in a translation carried out by Newton's friend and supporter Samuel Clarke.[31] According to William Whiston, Newton bestowed on Clarke no less than £500 for his labours (£100 for each of Clarke's five children).[32] Newton was sixty-three when the book appeared—hardly an advanced age (especially considering the fact that he would live for another two decades). Evidently Newton saw the appearance of the *Opticks* in Latin dress as an opportunity to reveal some hints about his views on the relationship of natural philosophy to natural theology and religion.[33] Included amongst two of the seven new and elaborate Queries added after the original sixteen pithy Queries were bold statements about natural theology, design in nature, the corruption of idolatry and God, "our true and most beneficent Author" ("*verus noster & beneficentissimus Author*").[34] The revelations of the Latin Queries 20 and 23 were made available to the English reader in second English edition of 1717 with minor modifications in the arrangement of the material.[35] In adding these statements, Newton was not only introducing some of the ideas present in his draft preface to the first edition of the *Opticks*, but was drawing back the curtain—ever so slightly—on decades of study on the wisdom of the ancients, pagan polytheism, theology and the corruption of religion.

In the opening sentence of Query 28 (20) Newton nails his colours to the mast by launching

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[31]Newton, *Optice: sive de reflexionibus, refractionibus, inflexionibus & coloribus lucis libri tres* (London, 1706).

[32]Whiston, *Historical memoirs of the life of Dr. Samuel Clarke* (London, 1730), p. 13.

[33]See also the useful discussions of natural theology in the *Opticks* provided in Hall, *All was light*, pp. 135-8, 150-151, 162.

[34]Newton, *Optice*, pp. 293-348 (citation from p. 348). These new Queries are assigned the numbers 17 to 23 in the 1706 edition. When eight additional Queries were introduced after the original sixteen in the second English edition of 1717, the Queries added in 1706 were renumbered 25 to 31 (see Hall, *All was light*, p. 238).

[35]In the 1717 edition, along with all subsequent editions, these Queries are numbered 28 and 31. With a few stated exceptions, I refer to the numbering and text of the 1717 edition in what follows. In all, there were four editions of the *Opticks* (1704, 1717, 1721 and 1730; the 1717 edition was re-issued in 1718 with a different title-page), two editions of the *Optice* (1706 and 1719) and two editions of the *Traité d'Optique* (1720 and 1722), which was translated by Pierre Coste (see Hall, *All was light*, pp. 237-38). Aside from the Queries added in 1717, there were few significant changes in the text after the *Optice* of 1706 (*cf.* Hall, *All was light*, p. 93).

into an assault on the pressure theory of light: "Are not all Hypotheses erroneous, in which Light is supposed to consist in Pression or Motion, propagated through a fluid Medium?"[36] Few informed readers would have mistaken this for anything other than an attack on the optical theory of Descartes. Seven years later Newton would begin his equally apologetic General Scholium to the *Principia* in a similar fashion. In this case, he commenced with a single-sentence dismissal of another of Descartes' well-known theories with the statement (or understatement): "The hypothesis of vortices is beset with many difficulties".[37] This is but the first of many parallels between Queries 28 and 31 of the *Opticks* and the General Scholium to the *Principia*. Over the next few pages of Query 28, Newton argues against the existence of a dense fluid, contending that it "can be of no use for explaining the Phænomena of Nature, the Motions of the Planets and Comets being better explain'd without it".[38] If this dense fluid is rejected, Newton concludes, "the Hypotheses that Light consists in Pression or Motion propagated through such a Medium, are rejected with it".[39]

Immediately after this statement, in the opening words of the concluding paragraph, Newton turns to topics that had been dear to his heart for decades, but that had not seen previous expression in his publications. For the rejection of the dense fluid, Newton claims, "we have the Authority of those the oldest and most celebrated Philosophers of *Greece* and *Phœnicia*, who made a *Vacuum* and Atoms, and the Gravity of Atoms, the first Principles of their Philosophy; tacitly attributing Gravity to some other Cause than dense Matter".[40] In this brief statement Newton sums up one of the main contentions of his "Classical Scholia" of the early 1690s, namely, that his doctrine of universal

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[36]Newton, *Opticks: or, a treatise on the reflections, refractions, inflections and colours of light* (London, 1717), p. 336.

[37]Newton, *Principia*, p. 939.

[38]Newton, *Opticks* (1717), p. 343.

[39]Newton, *Opticks* (1717), p. 343.

[40]Newton, *Opticks* (1717), pp. 343-44.

gravitation was a recovery of similar ideas held by the ancients, including the Epicureans and the Pythagoreans. More generally, the manuscript Classical Scholia explicated Newton's version of the *prisca sapientia*, that the ancient pre-Socratic Greek, Egyptian and Babylonian philosophers had possessed a sophisticated knowledge of nature, later lost or corrupted, that included not only an awareness of a heliocentric solar system, but also the Inverse-Square Law of gravitation.[41] Newton's suggestive statement about the ancients "attributing Gravity to some other Cause than dense Matter" is not made explicit at this point in Query 28, but it is clear from his private writings (including the "Classical Scholia") and less guarded comments he made to friends, that he saw God's omnipresence as the leading candidate to explain the cause and ubiquity of gravity.[42] After this hint, Newton goes on to outline in a cursory fashion another position detailed in much more open way in the Classical Scholia, namely the corruption of the most ancient philosophy of nature:

> Later Philosophers banish the Consideration of such a Cause out of Natural Philosophy, feigning Hypotheses for explaining all things mechanically, and referring other Causes to Metaphysicks: Whereas the main Business of Natural Philosophy is to argue from Phænomena without feigning Hypotheses, and to deduce Causes from

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[41]On the Classical Scholia, see J.E. McGuire and P.M. Rattansi, "Newton and the 'Pipes of Pan'," *Notes and Records of the Royal Society* 21 (1966): 108-43 and Paolo Casini, "Newton: the Classical Scholia", *History of Science* 22 (1984): 1-58; a modern critical edition of the "Classical Scholia" is available in Volkmar Schüller, "Newton's *Scholia* from David Gregory's estate on the Propositions IV through IX Book III of his *Principia*", in *Between Leibniz, Newton, and Kant: philosophy and science in the eighteenth century*, ed. Wolfgang Lefèvre (Dordrecht: Kluwer, 2001), pp. 213-65. Newton is careful to portray the Epicurean philosophy as wrongly characterised as atheistic (Gregory in Newton, *Correspondence*, 3:335, 338). Some passages from Newton's "Classical Scholia" were published in David Gregory's *Elementa astronomiae physicae et geommetricae* (London, 1702), but without attribution to Newton .A reprint of the relevant section of Gregory's *Elementa* can be found in Casini, "Newton: the Classical Scholia", pp. 47-58.

[42]Newton expressed this supposition privately to Nicolas Fatio de Duillier, David Gregory, Christopher Wren and William Whiston (Newton, *Correspondence*, 3: 308-9; Newton, *The correspondence of Isaac Newton*,ed. J.F. Scott [Cambridge: Cambridge University Press, 1967], 4: 266, 267; David Gregory, *Isaac Newton and their circle: extracts from David Gregory's memoranda 1677-1708*, ed. W.G. Hiscock [Oxford: Printed for the Editor, 1937], p. 30; Whiston, *A collection of authentick records belonging to the Old and New Testament* [London, 1728], II: 1072-3). In the Classical Scholia, Newton asserts that the ancients had viewed God as the cause of gravity (Newton in Schüller, "Newton's *Scholia*", p. 241). On this topic, see John Henry, "'Pray do not ascribe that notion to me': God and Newton's gravity," in *The Books of Nature and Scripture: recent essays on natural philosophy, theology, and biblical criticism in the Netherlands of Spinoza's time and the British Isles of Newton's time*, ed. James E. Force and Richard H. Popkin (Dordrecht: Kluwer, 1994), pp. 123-47.

Effects, till we come to the very first Cause, which certainly is not mechanical.[43]

Although Descartes and the Cartesians are nowhere here specifically mentioned, the reference to those who feign hypotheses "for explaining all things mechanically" is aimed directly at the French philosopher and his followers. Newton instead appeals for an inductive approach to the study of nature that would eventually yield knowledge of "the very first Cause". What cause this might be he next turns to make explicit.

Newton, who by the time he composed the *Principia* had come to view unbridled mechanism as an open door to atheism, wastes no time in the conclusion of Query 28 to provide examples of where his proposed inductive approach would lead.

> What is there in places almost empty if Matter, and whence is it that the Sun and Planets gravitate towards one another, without sense Matter between them? Whence is it that Nature doth nothing in vain; and whence arises all that Order and Beauty which we see in the World? To what end are Comets, and whence is it that Planets move all one and the same way in Orbs concentrick, while Comets move all manner of ways in Orbs very excentrick, and what hinders the fix'd Stars from falling upon one another?[44]

An explicit response to the second question appeared in the General Scholium of 1713: "This most elegant system of the sun, planets, and comets could not have arisen without the design and dominion of an intelligent and powerful being".[45] A direct answer to the question "what hinders the fix'd stars from falling upon one another?" was also provided in the General Scholium of 1713: "And so that the systems of the fixed stars will not fall upon one another as a result of their gravity, [God] has placed them at immense distances from one another".[46] With respect to the concentric

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[43]Newton, *Opticks* (1717), p. 344.
[44]Newton, *Opticks* (1717), p. 344.
[45]Newton, *Principia*, p. 940.
[46]Newton, *Principia*, p. 940.

motion of the planets and the eccentric movements of the comets, Newton implies in Query 28 and makes explicit in the General Scholium that these different species of motion cannot have their origin purely from mechanical causes.[47] These ideas were not new to Newton in 1706. In his celebrated correspondence with Richard Bentley in the early 1690s, Newton had explicitly stated his belief that the concentric motions of the planets and the eccentric motions of the comets pointed to a cause that was not "blind & fortuitous, but very well skilled in Mechanicks & Geometry."[48] In May 1694, Newton told Gregory that "a continual miracle is needed to prevent the Sun and the fixed stars from rushing together with gravity" and "that the great eccentricity in Comets in directions both different from and contrary to the planets indicates a divine hand".[49]

From leading questions about the divine order of the macrocosm Newton next turns to the divine art of the microcosm:

> How came the Bodies of Animals to be contrived with so much Art, and for what ends were their several Parts? Was the Eye contrived without Skill in Opticks, and the Ear without Knowledge of Sounds? How do the Motions of the Body follow from the Will, and whence is the Instinct in Animals? Is not the Sensory of Animals that place to which the sensitive Substance is present, and into which the sensible Species of Things are carried through the Nerves and Brain, that there they may be perceived by their immediate presence to that Substance?[50]

Just as the system of the world is not the result of chance, nor can the physiological structures of living beings be an accident of nature. And just as Newton had earlier stated that the Creator of the cosmos was highly skilled in mechanics and geometry, so the Creator must have skilled expertise

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[47]Newton, *Principia*, p. 940.

[48]Newton to Bentley, 10 December 1692,in Newton, *Correspondence*, 3:235. In his famous four letters to Bentley of 1692-1693, Newton provides the young clergyman with examples of how the mathematical physics of the *Principia* could be used for natural theological ends. Bentley had sought out Newton's help when revising his Boyle Lectures (1692) for the press. The four letters, with notes, are published in Newton, *Correspondence*, 3: 233-41, 244-45, 253-56.

[49]Gregory, Memoranda dated 5, 6 and 7 May 1694 in Newton, *Correspondence*, 3: 336.

[50]Newton, *Opticks* (1717), pp. 344-45.

in optics and the phenomenon of sound. Newton then begins to return to the macrocosm. By demonstrating the existence of a "Sensory" in animals, he establishes an intuitive analogy for the central claim in the conclusion to Query 28. Although an inquisitive reader would have had to wait until 1713 to encounter explicit answers to some of these questions, Newton provides a general answer in the conclusion, which comes immediately after the last-quoted series of questions.

> And these things being rightly dispatch'd, does it not appear from Phænomena that there is a Being incorporeal, living, intelligent, omnipresent, who in infinite Space, as it were in his Sensory, sees the things themselves intimately, and thoroughly perceives them, and comprehends them wholly by their immediate presence to himself: Of which things the Images only carried through the Organs of Sense into our little Sensoriums, are there seen and beheld by that which in us perceives and thinks.[51]

Once again, it is the intelligent and living God who provides the underlying unity in nature. God's omnipresence is the ground of the unity of phenomena. If God is everywhere present, then he is also immediately aware of and present with (but not the same as) all of physical reality. This, the text hints, also explains what upholds the phenomena of nature—including the equilibrium holding the fixed stars in place. Through his omnipresence, God is able to act directly and immediately on phenomena anywhere in the cosmos.

Newton concludes Query 28 with an affirmation of the natural philosophical method he has just employed with some specific examples: "And tho' every true Step made in this Philosophy brings us not immediately to the Knowledge of the first cause, yet it brings us nearer to it, and on that account is to be highly valued".[52] Here Newton is unambiguous: natural philosophy pursued by an inductive method will ultimately lead to God. In stark contrast to Descartes, who begins with God

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[51]Newton, *Opticks* (1717), p. 345.
[52]Newton, *Opticks* (1717), p. 345.

and then moves outwards deductively, Newton begins with phenomena and moves inductively towards God. In a work that champions the inductive method, it is also noteworthy that the natural theological arguments of Query 28 are inductive through and through.

Natural theology and the assault on atheism in Query 31

Newton returns to natural theology in the concluding five paragraphs of Query 31 (23), the last and longest of the queries. Already substantial, Newton added further material to Query 23 of the Optice when it first appeared in English as Query 31 in 1717, including an account of some experiments of Francis Hauksbee, Sr. and a rebuttal about God's *sensorium* aimed at Leibniz. Thus, even allowing for one significant deletion from the Latin Query 23, the final query is even longer in the later English editions.[53] As it happens, Query 31 is just over thirty-one pages in the 1717 English edition.[54] Newton opens this query with the proposal that both attraction and action at a distance, already demonstrated in the *Principia* as applying at macrocosmic scales to the planets, also hold true for small particles at microcosmic scales:

> Have not the small Particles of Bodies certain Powers, Virtues or Forces, by which they act at a distance, not only upon the Rays of Light for reflecting, refracting and inflecting them, but also upon one another for producing a great part of the Phænomena of Nature? For it's well known that Bodies act one upon another by the Attractions of Gravity, Magnetism and Electricity; and these Instances shew the Tenor and Course of Nature, and make it not improbable but that there may be more attractive Powers than these. For Nature is very consonant and conformable to her self.[55]

The last sentence confirms that Newton had come to expect symmetry and unity in Nature. This

[53]Hall, *All was light*, pp. 145-6.

[54]Newton, *Opticks* (1717), pp. 350-382. This can be compared with the five pages the first sixteen queries took up in the 1704 edition (Newton, *Opticks* [1704], pp. 132-137).

[55]Newton, *Opticks* (1717), pp. 350-351.

symmetry and unity, he believed, existed in both the macrocosmic and microcosmic worlds and thus formed a link between them. By observing examples of the phenomenon of attraction in the specific "Instances" of gravity, magnetism and electricity, he induced a general conclusion about "the Tenor and Course of Nature". Newton's confidence in this fundamental cosmic unity was such that it led him to conclude that the phenomenon of attraction in gravity, magnetism and electricity, already observed with "vulgar Eyes", also operates at scales smaller than those hitherto observed (he refers specifically to electrical attraction).[56] Once again, the reasoning is inductive.

At this point, using examples derived from chemical (alchemical) experimentation, Newton launches into an extended discussion on corpuscularian matter theory in which he speaks about potential examples of attraction between particles of matter.[57] One of the goals of this discussion is to find analogies between attraction at the macroscopic and microscopic levels. Partway through this material, and after proposing that "Salts are dry earth and watry Acid united by Attraction",[58] he offers an analogy between the globe of the earth and particles of salt: "As Gravity makes the Sea flow round the denser and weightier Parts of the Globe of the Earth, so the Attraction may make the watry Acid flow round the denser and compacter Particles of Earth for composing the Particles of Salt".[59] This analogy between phenomena on the terraqueous globe and in acid around a salt particle is based in part on seventeenth-century alchemical notions of oppositions between "centres" and "circumferences"—alchemical ideas with which Newton was familiar.[60] An example added to the 1717 English edition relates to some experiments carried out by his assistant Francis Hauksbee on

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[56]Newton, *Opticks* (1717), p. 351.
[57]Newton, *Opticks* (1717), pp. 351-375.
[58]Newton, *Opticks* (1717), p. 360.
[59]Newton, *Opticks* (1717), p. 361.
[60]William Newman, "The background to Newton's chemistry", in Cohen and Smith, eds., *Cambridge companion to Newton*, pp. 365-366.

liquid capillarity. Newton concludes his account of these experiments by stating: "There are therefore Agents in Nature able to make the Particles of Bodies stick together by very strong Attractions. And it is the Business of experimental Philosophy to find them out".[61] In this appeal for the discovery of these agents, Newton declares both one of the primary purposes of experimental philosophy as well as one of its most important research agendas.

Later, Newton suggests analogies between attractive and repulsive dynamics in chemical, algebraic, mechanical and optical phenomena.[62] Later yet, he reasons:

> And thus Nature will be very conformable to her self and very simple, performing all the great Motions of the heavenly Bodies by the Attraction of Gravity which intercedes those Bodies, and almost all the small ones of their Particles by some other attractive and repelling Powers which intercede the Particles.[63]

Once again, Newton is awed by the apparent structural unities in nature. Three pages after this, he proposes the existence of certain active principles in nature that are required due to the tendency of motion in the universe to decay and decrease over time. Among other things, these active principles prevent the degradation of the orbits of plants and comets, cause fermentation, sustain the heart and blood in animals, warm the inner parts of the earth and keep the sun "violently hot and lucid".[64] He concludes:

> And if it were not for these Principles the Bodies of the Earth, Planets, Comets, Sun, and all things in them would grow cold and freeze, and become inactive Masses; and all Putrefaction, Generation, Vegetation and Life would cease, and the Planets and Comets would not remain in their Orbs.[65]

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[61]Newton, *Opticks* (1717), p. 369.
[62]Newton, *Opticks* (1717), pp. 370-371.
[63]Newton, *Opticks* (1717), p. 372.
[64]Newton, *Opticks* (1717), p. 375.
[65]Newton, *Opticks* (1717), p. 375. Newton's description of "the Bodies of the Earth, Planets, Comets, Sun, and all things in them" may be dependent on a series of similar biblical formulae for creation and its contents (*e.g.* Acts 17:24: "God that made the world and all things therein"; see also Genesis 2:1, Deuteronomy 10:14, Nehemiah 9:6 Psalm 146:6, Acts 14:15 and Revelation 10:6). Newton had used a similar formula in his draft preface to the *Opticks* when he

The propensity of nature to sustain and regenerate itself in the face of decay and decline is clearly a dynamic that Newton finds remarkable and worthy of comment. But what is the ultimate cause behind these self-correcting phenomena? He begins to suggest an answer in the next paragraph.

Having devoted many pages to outlining examples of attraction at the microcosmic scale, Newton turns to consider the origin of the particles or corpuscles themselves:

> All these things being consider'd, it seems probable to me, that God in the Beginning form'd Matter in solid, massy, hard, impenetrable, moveable Particles, of such Sizes and Figures, and with such other Properties, and in such Proportion to Space, as most conduced to the End for which he form'd them; and that these primitive Particles being Solids, are incomparably harder than any porous Bodies compounded of them; even so very hard, as never to wear or break in pieces: No ordinary Power being able to divide what God himself made one in the first Creation.[66]

Not only does Newton assign the origin of these small and hard particles to God's creative hand, but he speaks in teleological terms of God designing these particles for specific ends. Newton also attributes to these hard, impenetrable particles a *vis inertiae*, which are "accompanied" with "passive Laws of Motion" and "certain active Principles" such as gravity and the causes of fermentation and cohesion.[67] But he is quick to distinguish these "general Laws of Nature" from the discredited notion of occult qualities.[68] "Such occult Qualities", he says, "put a stop to the Improvement of natural Philosophy, and therefore of late Years have been rejected". At this point, he champions the inductive method: "But to derive two or three general Principles of Motion from Phænomena, and afterwards to tell us how the Properties and Actions of all corporeal Things follow from those

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wrote about "the world and all the species of things therein" being "originally framed by [God's] power and wisdom" (Newton in McGuire, "Newton's 'Principles of philosophy'", p. 183).

[66]Newton, *Opticks* (1717), pp. 375-376. The words "in the Beginning" are likely an allusion to the words of Genesis 1:1 ("In the beginning God created the heaven and the earth"). A second allusion to creation comes in the final line of this quotation.

[67]Newton, *Opticks* (1717), p. 376.

[68]Newton, *Opticks* (1717), pp. 376-377.

manifest Principles, would be a very great step in Philosophy".[69] Yet, as with his brief discussion of gravity in the General Scholium, he does not attempt to suggest the causes of these "Principles of Motion".[70]

This statement of nescience about the causes behind the phenomena of micromatter notwithstanding, Newton returns to natural theology at the beginning of the next paragraph, which commences: "Now by the help of these Principles, all material Things seem to have been composed of the hard and solid Particles above mention'd, variously associated in the first Creation by the Counsel of an intelligent Agent".[71] To this he adds: "For it became him who created them to set them in order. And if he did so, it's unphilosophical to seek for any other Origin of the World, or to pretend that it might arise out of Chaos by the mere Laws of Nature".[72] The word "unphilosophical" was a particularly strong word in Newton's vocabulary. He had used the very same term in his draft preface to the *Opticks* when he had concluded that it was "unphilosophical" to lay aside the argument that the world and all its species were created by God's power and wisdom.[73] But there is much more.

Returning again to the argument about evidence for design in both the macrocosm of the solar system and the microcosm of animal bodies presented earlier in the conclusion to Query 28, Newton declares:

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[69]Newton, *Opticks* (1717), p. 377.

[70]Newton, *Opticks* (1717), p. 377. In the penultimate paragraph of the General Scholium, Newton offers a descriptive account of the phenomenon of universal gravitation, including the Inverse-Square Law, but acknowledges that he has "not as yet been able to deduce from phenomena the reason for these properties of gravity", stating instead that "it is enough that gravity really exists and acts according to the laws that we have set forth and is sufficient to explain all the motions of the heavenly bodies and of our sea" (Newton, *Principia*, p. 943).

[71]Newton, *Opticks* (1717), pp. 377-378.

[72]Newton, *Opticks* (1717), p. 378.

[73]Newton in McGuire, "Newton's 'Principles of philosophy'", p. 183.

> For while Comets move in very excentrick Orbs in all manner of Positions, blind Fate could never make all the Planets move one and the same way in Orbs concentrick, some inconsiderable Irregularities excepted which may have risen from the mutual Actions of Comets and Planets upon one another, and which will be apt to increase, till this System wants a Reformation.[74]

Once again Newton alludes to the tendency of the orbits of the comets and plants to degrade over time, thus necessitating a "Reformation", a word with strong resonances with the realm of religion. His very next line asserts the origin of this system: "Such a wonderful Uniformity in the Planetary System must be allowed the Effect of Choice",[75] words echoed in the General Scholium of 1713, when he wrote: "This most elegant system of the sun, planets, and comets could not have arisen without the design and dominion of an intelligent and powerful being".[76] The same, Newton contends, is true of the "Uniformity in the Bodies of Animals",[77] after which he deploys the same argument about symmetry in the bodily structure of animals as he outlined in his draft preface a few years before.[78] To this he adds that "the first Contrivance of those very artificial Parts of Animals, the Eyes, Ears, Brain, Muscles, Heart, Lungs, Midriff, Glands, Larynx, Hands, Wings, Swimming Bladders, natural Spectacles, and other Organs of Sense and Motion", along with their instinct, "can be the effect of nothing else than the Wisdom and Skill of a powerful ever-living Agent, who being in all Places, is more able by his Will to move the Bodies within his boundless uniform Sensorium, and thereby to form and reform the Parts of the Universe, than we are by our Will to move the Parts of our own Bodies".[79] As in the draft preface and in Query 28, Newton sees in God's omnipresence a powerful argument for uniformity in nature—in this case a uniformity of action. It is also through

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[74]Newton, *Opticks*, p. 378.
[75]Newton, *Opticks*, p. 378.
[76]Newton, *Principia*, p. 940.
[77]Newton, *Opticks*, 378.
[78]Newton, *Opticks*, 402-403.
[79]Newton, *Opticks*, pp. 378-379.

his omnipresence that God is also able to effective creative and recreative processes in nature.

A surviving manuscript draft of Query 23 of the *Optice* reveals that Newton had contemplated even stronger statements than these. Written shortly before the Latin edition was published in 1706,[80] the draft begins with a question about the cause of gravity:

> By what means do bodies act on one another at a distance? The ancient Philosophers who held Atoms and Vacuum attributed gravity to Atoms without telling us the means unless perhaps in figures: as by calling God Harmony and representing him and matter by the God Pan and his Pipe, or by calling the Sun the prison of Jupiter because he keeps the Planets in their orbs. Whence it seems to have been an ancient opinion that matter depends upon a Deity for its laws of motion as well as for its existence.[81]

In a concise summary of his unpublished "Classical Scholia" of the early 1690s, in which he had expressed his belief that his philosophy was but a recovery of the ancient wisdom (*prisca sapientia*), Newton attributes to the ancients both his phenomenalism and his belief that gravity relied on the spatial ubiquity of God. While nothing so bold found its way into the final version of Query 23/31, the erasure of the public text had come surprisingly close. Several sentences later he expands on his understanding of the divine "sensorium":

> And since all matter duly formed is attended with signs of life and all things are framed with perfect art and wisdom and Nature does nothing in vain, if there be an universal life and all space be the sensorium of a thinking being who by immediate presence perceives all things in it as that which thinks in us perceives their pictures in the brain and finite things therein ... the laws of motion arising from life or will may be of universal extent.[82]

For Newton, then, there is a direct causal connection between the universal nature of the laws of motion and the universal extent of God's presence. When he continues, he once again mentions the

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[80]Westfall estimates that the draft was written around the year 1705 (Westfall, *Never at Rest*, p. 647).
[81]Newton, Cambridge University Library Ms. Add. 3970 (B), f. 619r.
[82]Newton, Cambridge University Library Ms. Add. 3970 (B), f. 619r.

views of the ancients, this time alluding to the Pythagorean notion of the music of the spheres:

> To some such laws the ancient Philosophers seem to have alluded when they called God Harmony, and signified his actuating matter harmonically by the God Pan's playing upon a Pipe and attributing musick to the spheres made the distances and motions of the heavenly bodies to be harmonical, and represented the Planets by the seven strings of Apollo's Harp.[83]

Although Newton removed explicit references to these ancient analogues from the published version of Query 23/31, the theological understanding of gravity and the universality of natural phenomena remained.

Newton also uses the draft of Query 23 to argue for a tight link between empiricism in natural philosophy and empiricism in natural theology. "Reasoning without experience is very slippery", he avers. He goes on to elaborate:

> A man may puzzle me by arguments against local motion but I'll believe my eyes. A man may may bring plausible arguments against the power of the will but I'll believe experience. A man may argue plausibly for blind fate against final causes but I find by experience that ... I am constantly aiming at something. Were it not for experience I should not know that matter is heavy or impenetrable or moveable or that I think or am or that there is matter or any thing else. And therefore to affirm any thing more then I know by experience and reasoning upon it is precarious.[84]

This passionate advocation of experience is not only meant to challenge the effectiveness of a thorough-going rationalist methodology in natural philosophy (it is all but certain that Descartes is the principal target here), but to impugn the validity of *a priori* arguments for the existence of God:

> Even arguments for a Deity if not taken from Phænomena are slippery and serve only for ostentation. An Atheist will allow that there is a Being absolutely perfect, necessarily existing and the author of mankind and call it Nature.[85]

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[83]Newton, Cambridge University Library Ms. Add. 3970 (B), f. 619r.

[84]Newton, Cambridge University Library Ms. Add. 3970 (B), f. 619r. Newton's reference to not knowing without experience whether "I think or am" is likely a dig at Descartes' *cogito*.

[85]Newton, Cambridge University Library Ms. Add. 3970 (B), f. 619r. Newton may have had in mind the ontological argument of Anselm, but it seems likely that here as well his chief target is Descartes. The Newtonian Samuel Clarke used *a priori* as well as *a posteriori* arguments for the existence of God. See Clarke, *A demonstration of the being*

Thus for Newton *a priori* reasoning can lead to error in both the study of nature and the understanding of God. As a method, the rational approach is doubly sinful. An inductive approach, on the other hand, will lead to truth in both natural philosophy and religion.

In addition to its effectiveness, another virtue of an empirical natural theology is that it can be understood by all:

> Metaphysical arguments are intricate and understood by few. The argument which all men are capable of understanding and by which the belief of a Deity has hitherto subsisted in the world is taken from the Phænomena. We see the effects of a Deity in the creation and thence gather the cause and therefore the proof of a Deity and what are his properties belongs to experimental Philosophy.[86]

Here Newton asserts another value of experiment: "the proof of a Deity". But in making this claim he is also contending that natural theology belongs in the domain of experimental philosophy. As in his earlier "Principles of Philosophy" and in his later General Scholium, Newton sees the discovery of God in nature as one of the chief ends of natural philosophy.[87] Even more direct is the claim he makes in the next sentence: "Tis the business of this Philosophy to argue from the effects to their causes till we come at the first cause and not to argue from any cause to the effect till the cause as to its being and quality is sufficiently discovered".[88] Who or what is this "first cause"? The term appears not only in this manuscript, but also Query 28 and Query 31. Even the public examples in the *Opticks* imply that Newton is ultimately referring to the God of the Bible.

Although there are no explicit attacks on atheism in Query 31, Newton's "A short Scheme

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and attributes of God and other writings, ed. Ezio Vailati (Cambridge: Cambridge University Press, 1998), pp. 112-113, 118-122.

[86]Newton, Cambridge University Library Ms. Add. 3970 (B), f. 619v. Newton first began to write "Natural" at the end of the last sentence, but struck it through and replaced it with the word "experimental".

[87]Compare also Sotheby's Lot 255.1, where Newton writes: "The wisdom and power which appears in the frame of the world and its various parts is sufficient to convince men that they were framed by a wise and powerful being" (Newton, Sotheby's (1936) Lot 255.1, f. 1r, private collection).

[88]Newton, Cambridge University Library Ms. Add. 3970 (B), f. 619v.

of the true Religion", one of his private manuscripts from the same period, reveals that the argument from symmetry in nature was for him not only an example of positive apologetics, but negative apologetics directed against atheism:

> Of Atheism
>
> Opposite to [loving God] is Atheism in profession and Idolatry in practise. Atheism is so senseless and odious to mankind that it never had many professors. Can it be by accident that all birds beasts and men have their right side and left side alike shaped (except in their bowells) and just two eyes and no more in either side the face and just two ears on either side [of] the head and a nose with two holes and no more between the eyes and one mouth under the nose and either two fore leggs or two wings or two arms on the sholders and two leggs on the hipps one on either side and no more? Whence arises this uniformity in all their outward shapes but from the counsel and contrivance of an Author? Whence is it that the eyes of all sorts of living creatures are transparent to the very bottom and the only transparent members in the body, having on the outside an hard transparent skin, and within transparent juyces with a crystalline Lens in the middle and a pupil before the Lens all of them so truly shaped and fitted for vision, that no Artist can mend them? Did blind chance know that there was light and what was its refraction and fit the eys of all creatures after the most curious manner to make use of it? These and such like considerations always have and ever will prevail with man kind to believe that there is a being who made all things and has all things in his power and who is therfore to be feared.[89]

In this manuscript Newton articulates in a context that is more explicit in its apologetics his now familiar argument from symmetry in nature, an argument already encountered in the 1704 draft preface and Queries 28 and 31. He also includes a specific reference to the exquisite design of the eye. Not only had Newton discussed the physiology of the eye in the first edition of the *Opticks*,[90] but he spoke about the eye in natural theological terms both in the draft preface and the queries he added to the 1706 *Optice*. In the draft preface he had written, "Certainly he that framed the eyes of all creatures understood the nature of light and vision";[91] in Query 28 he had asked, "Was the Eye

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[89]Newton, Keynes MS 7, p. 1.

[90]This is found in Axiom VII near the beginning of the *Opticks* (Newton, *Opticks* [1704], pp. 9-11). See also the associated Figure 8 at the end of Book I, Part I, which illustrates the optical features of the eye.

[91]Newton in McGuire, "Newton's 'Principles of philosophy'", p. 183.

contrived without Skill in Opticks?";[92] in Query 31 he had attributed the eyes, amongst other things, to "the Wisdom and Skill of a powerful ever-living Agent".[93] Just as Newton was able to design a more efficient telescope once he understood an important principle of optics (namely, that light consists of "rays differently refrangible"), so God with his infinite knowledge of optics and light was able to design a most efficient organ of sight.

When Newton included natural theological arguments in the queries added to the Latin *Optice*, he was allowing a feature of his private thinking to shine through, just as he had allowed a ray of sunlight to pass through an opening in a shutter in his experiments with the prism. Although a literary shutter still blocked much of his private thinking about theology, our access to his unpublished papers provides additional colour. Thus, the draft of Query 23 and the "Short Scheme of the true Religion" show that an attack against atheism simmered just below the surface in the published texts. Nor were these arguments the product of the degeneration of Newton's "old age". A full forty years before the publication of the *Optice*, Newton had already committed himself to the view that symmetry in nature was the result of design, not chance. In his undergraduate notebook "Questiones quædam philosophicæ" ("Certain philosophical questions"), Newton wrote the following under the heading "Of God":

> Were men and beasts made by fortuitous jumblings or atoms there would be many useless parts in them, here a lump of flesh, there a member too much. Some kinds of beasts might have had but one eye, some more than two, and others two eyes.[94]

Natural theology was not a *post facto* rationalisation of his career of natural philosophical

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[92]Newton, *Opticks* (1717), p. 344.

[93]Newton, *Opticks* (1717), pp. 378-379 (quotation from p. 379).

[94]Newton, *Certain philosophical questions: Newton's Trinity notebook*, ed. J.E. McGuire and Martin Tamny (Cambridge: Cambridge University Press, 1983), p. 447. This notebook dates from the years 1661 to 1665.

investigation. It was there all along.

The *Opticks* and the dual reformation

But there is more than natural theology and anti-atheism simmering below the surface of the *Opticks*. While a book of "science" that includes natural theological and anti-atheist apologetics may clash with the sensibilities of some modern scientists and historians of science, these agendas were commonly associated with natural philosophy at the beginning of the eighteenth century. Newton's radical theology is a different matter altogether. Newton's private theological manuscripts have been examined in recent decades and this analysis has confirmed that the author of the *Principia* and *Opticks* was a passionate theologian who wrote thousands upon thousands of pages on church history, doctrine, prophecy, idolatry, ancient temples, primitive religion and the *prisca sapientia*. These manuscripts also reveal that Newton ventured into heresy, including the denial of the doctrine of the Trinity—the chief tenet of orthodox Christianity. Denial of the Trinity was illegal in Britain throughout Newton's lifetime and open attacks on the dogma brought censure or worse. The same manuscripts that demonstrate Newton's unorthodox theological beliefs show that these beliefs form a subtext to the final query of the *Opticks*. Despite the legal danger, this subtext includes heresy. Just as he introduced the General Scholium—a text replete with overt natural theology and hidden heresy—at the conclusion of the second edition of the *Principia* in 1713, so Newton rounded off the later editions of the *Opticks* in a similar manner. And, as with the General Scholium,[95] the esoteric

[95]This is one of the main purposes of Snobelen, "'God of Gods, and Lord of Lords'" (cited in full above). See also Larry Stewart, "Seeing through the Scholium: religion and reading Newton in the eighteenth century", *History of Science* 34 (1996): 123-65; James E. Force, "Newton's God of dominion: the unity of Newton's theological, scientific, and political thought," in Force and Richard H. Popkin, *Essays on the context, nature, and influence of Isaac Newton's theology* (Dordrecht: Kluwer, 1990), pp. 75-102.

features of Query 31 can be illuminated by the light of the less oblique testimony of his private papers.

In the antepenultimate paragraph of Query 31, as discussed above, Newton attributes the structure of the solar system and the symmetry manifest in animal physiology to "the Wisdom and Skill of a powerful ever-living Agent". At this point in the *Optice* of 1706 Newton qualifies this description of the Deity as the one

> who is everywhere present and who is able, by his will, to move all bodies in his infinite *Sensorium*, and thus form and reform all parts of the entire universe according to his choice, by a much greater degree than our soul, which is the image of God [*Imago Dei*] in us, is able to move the members of its body by its will.[96]

Partly because Leibniz had read Newton's reference to God's *sensorium* in Query 20 (28) in a literal way, Newton refashioned these lines and inserted after them a much longer statement on God's omnipresence.[97] This begins with a disclaimer:

> And yet we are not to consider the World as the Body of God, or the several Parts thereof, as the Parts of God. He is an uniform Being, void of Organs, Members or parts, and they are his Creatures subordinate to him, and subservient to his Will.

Newton had already spoken out against the notion of God having a body in the General Scholium of 1713 and 1726.[98] Likewise, the same text speaks of God as a uniform being ("all eye, all ear, all brain, all arm, all force of sensing, of understanding, of acting")—all in "a way not at all human".[99] Newton's stress on primacy of God's will and the subjection of his creatures to him emanates from his theological voluntarism[100] and his conception of a God of dominion, with the later conception

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[96]Newton, *Optice* (1706), p. 346 (my translation). The expression "image of God" derives from Genesis 1:27.
[97]See Hall, *All was light*, pp. 136-138.
[98]Newton, *Principia*, pp. 940, 942.
[99]Newton, *Principia*, p. 942.
[100]A vivid example of voluntarist thinking is found at the end of this paragraph in the query, where Newton proposes that God is able "to vary the Laws of Nature, and make Worlds of several sorts in several Parts of the Universe" (Newton, *Opticks* [1717], pp. 379-380).

also featuring prominently in the General Scholium.[101] Newton concludes the added material with the argument that God requires no organs of sensation, because he is "every where present to the Things themselves".[102] The theme of God's spatial ubiquity forms yet another link with the General Scholium to the *Principia*.[103] As in the General Scholium, Newton's private manuscripts make it clear that omnipresence and omniscience are qualities of the Father only, not the Son. Newton's "Twelve Statements on God and Christ", which was produced in the same period as the General Scholium and the first English edition of Query 31, not only makes these distinctions, but uses the same expression "ever-living" that appeared in the 1717 edition of Query 31.[104]

The penultimate paragraph of Query 31 is devoted to a discussion of right method in natural philosophy. He begins:

> As in Mathematicks, so in Natural Philosophy, the Investigation of difficult Things by the Method of Analysis, ought ever to precede the Method of Composition. This Analysis consists in making Experiments and Observations, and in drawing general Conclusions from them by Induction.[105]

"For", Newton declares, "Hypotheses are not to be regarded in experimental Philosophy",[106] a declaration that can be compared to the words "hypotheses non fingo" ("I feign no hypotheses") of the General Scholium.[107] In the final paragraph of Query 31, Newton continues this theme by stating that he had followed this two-stage process in the first two books of the *Opticks*. "In the third Book", he writes, "I have only begun the Analysis of what remains to be discover'd about Light and its

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[101]Newton, *Principia*, pp. 940-942.

[102]Newton, *Opticks* (1717), p. 379. As Hall astutely concludes, the new material both served as "a riposte to Leibniz" and as "an attempt by Newton to detach his philosophy from pantheism (Hall, *All was light*, p. 138).

[103]See Newton, *Principia*, pp. 941-942.

[104]Newton, Keynes MS 8.

[105]Newton, *Opticks* (1717), p. 380.

[106]Newton, *Opticks* (1717), p. 380.

[107]Newton, *Principia*, p. 943.

Effects upon the Frame of Nature, hinting several things about it, and leaving the Hints to be examin'd and improved by farther Experiments and Observations of such as are inquisitive".[108] Although Newton does not spell out explicitly if he knew more about these hints than he was letting on, it is certain that Newton here is encouraging a heuristic agenda of experimentation.

It is at this point that Newton returns to theology and natural theology. Beginning with natural philosophy, he writes: "And if natural Philosophy in all its Parts, by pursuing this Method, shall at length be perfected, the Bounds of moral Philosophy will be also enlarged".[109] There is much in this sentence. First, it is evident from these words and what follows that in some way natural philosophy "in all its Parts" embraces moral law and religion as well as natural theology. This statement can be compared with the similar claims Newton makes elsewhere, including his writings on the original religion, where he says that the ancient priests were "well skilled in the knowledge of the true frame of Nature and accounted it a great part of their Theology";[110] the draft preface of the *Opticks*, where he presents God as a principle of philosophy; the conclusion of the theological portion of the General Scholium, where he asserts that "to treat of God from phenomena is certainly a part of experimental philosophy";[111] and the draft of Query 23, where he maintains that "the proof of a Deity and what are his properties belongs to experimental Philosophy".[112] It can also be compared with the concluding line of Query 28, where he had earlier proclaimed the natural theological benefits of the inductive method: "And tho' every true Step made in this Philosophy brings us not immediately to the Knowledge of the first cause, yet it brings us nearer to it, and on that account is to be highly

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[108]Newton, *Opticks* (1717), p. 381.
[109]Newton, *Opticks* (1717), p. 381.
[110]Newton, Yahuda MS 41, f. 7r.
[111]Newton, *Principia*, p. 943.
[112]Newton, Cambridge University Library Ms. Add. 3970 (B), f. 619v.

valued".[113] Thus, natural philosophy and theology share some aims. What is more, the inductive method championed by Newton is here said to have great utility in the development of an improved moral philosophy. For Newton, then, there is a dual reformation, one that will lead to improvements in natural philosophical knowledge and a related one that will help produce an improved understanding of God, his role in creation and his purpose with humanity. And, just as Newton expected advances in natural philosophy with right method, so he expected the enlargement of moral philosophy.

If there could be any uncertainty in the mind of the reader as to what Newton meant by "moral Philosophy", he clears this up in the following sentence: "For so far as we can know by natural Philosophy what is the first Cause, what Power he has over us, and what Benefits we receive from him, so far our Duty towards him, as well as that towards one another, will appear to us by the Light of Nature".[114] Newton has already spoken of God as the first cause at the end of Query 28. In the final sentence of Query 31 he speaks directly of the Creator. But Newton is much more specific in his private manuscripts. These less guarded writings make it clear that the "first cause" is none other than the Father.[115] Even in his natural philosophy, Newton's antitrinitarian view of God shines through. In addition to the discovery of the first cause through induction, natural philosophy can bring further religious knowledge, including God's power over humans, the blessings granted to them and "our Duty towards him, as well as that towards one another". Once again, Newton's "A short Scheme of the true Religion" provides clarification through verbal parallels:

Religion is partly fundamental and immutable partly circumstantial and mutable. The

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[113]Newton, *Opticks* (1717), p. 345.
[114]Newton, *Opticks* (1717), p. 381.
[115]*Cf.* Newton, Keynes MS 3, pp. 35, 38; Sotheby's Lot 255.1, f. 1r (private collection).

> first was the Religion of Adam, Enoch, Noah, Abraham Moses Christ and all the saints and consists of two parts our duty towards God and our duty towards man or piety and righteousness, which I will here call Godliness and Humanity.[116]

In the same text he further elaborates "our duty towards God and our duty towards man" as the two great commandments of Matthew 22:36-40: "Thou shalt love the Lord thy God with all thy heart, and with all thy soul, and with all thy mind" and "Thou shalt love thy neighbour as thyself".[117] Love of God and love of neighbour are therefore for Newton integral parts of his vision for natural philosophy.

But these are not the only distinguishing marks that separate Newton's natural philosophy from modern science. These things, Newton relates, "will appear to us by the Light of Nature". In yet another point of contact between Query 31 and the manuscript "A short Scheme of the true Religion", Newton writes in the latter that "when the Gentiles which have not the law do by [the light of] nature the things contained in the law these having not the law [of Moses] are [by the light of nature] a law unto themselves, which shew the work of the law written in their hearts, their conscience also bearing witness, and their thoughts the mean while accusing or excusing one another." Here Newton elaborates Romans 2:14-15 with the expression "the light of nature"—the very same expression inserted in the second to last sentence of Query 31. This elaboration of Romans 2:14-15 forms part of a more extensive exposition in "A short Scheme of the true religion" of Romans 1 and 2, a portion of the writings of Paul that includes the most explicit statement of natural theology in the New Testament: "For the invisible things of him from the creation of the world are clearly seen, being understood by the things that are made, even his eternal power and Godhead; so

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[116]Newton, Keynes MS 7, p. 1.
[117]Newton, Keynes MS 7, p. 1.

that they are without excuse" (Romans 1:20). In a manuscript parallel to "A short Scheme of the true Religion" that has recently come to light, Newton states explicitly that the two great commandments "are dictated by the light of nature and by the truth of them is manifested the truth of the law and the Prophets".[118] Thus there can be no doubt as to the meaning and intent of the expression "the Light of Nature" in Query 31.

But "A short Scheme of the true Religion" also speaks about the pure, ancient religion taught by Noah and his descendants being corrupted by idolatry and immorality. This goes a long way to explaining the illocutionary force of the last statement of Query 31. The final sentence of Query 31 (and thus of the *Opticks* as a whole) in the 1717 edition reads:

> And no doubt, if the Worship of false Gods had not blinded the Heathen, their moral Philosophy would have gone farther than to the four Cardinal Virtues; and instead of teaching the Transmigration of Souls, and to worship the Sun and Moon, and dead Heroes, they would have taught us to worship our true Author and Benefactor.[119]

Although there is some difference in the arrangement of the arguments, the English is a fairly accurate reflection of the content of the equivalent material in the Latin text of 1706. While the previous sentence outlined the godly result of illumination from the light of nature, this final sentence speaks of the results of the corrupt reading of the light of nature, with the word "blinded" serving as an ironic counterpoint to the word "light" in the previous sentence. The language used in this sentence comes straight from Newton's manuscript discussions about idolatry and false religion. Yet again, some of the closest parallels can be found in "A short Scheme of the true Religion". In this manuscript, Newton "For the more time and devotion one spends in the worship of false Gods

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[118]Newton, Sotheby's Lot 255.1, f. 1r (private collection).
[119]Newton, *Opticks* (1717), pp. 381-2.

the less he is able to spend in that of the true one".[120] Similarly, Newton writes about the transmigration of souls in this manuscript:

> The Egyptians and other heathens who propagated Idolatry beleived the transmigration of souls and accordingly taught that the souls of men after death went into several subjects as into the Ox Apis and other sacred animals of Egypt, into the Sun, Moon and stars, into Images consecrated to them, etc. and on this opinion grounded their worship of those subjects.[121]

The same document includes no less than ten references to the worship of dead men—references that may relate to Newton's heretical mortalist theology.[122]

A copy of the 1717 edition that forms part of the Babson Collection reveals that Newton toyed with a much bolder conclusion—a conclusion that would have exhibited a much more explicit declaration of his private views had it appeared in print:

> And no doubt, if the Worship of false Gods had not blinded the Heathen, their moral Philosophy would have gone farther than to the four Cardinal Virtues; and instead of teaching the Transmigration of Souls, and to worship the Sun and Moon, and dead Heroes, they would have taught us to worship our true Author and Benefactor, as their ancestors did before they corrupted themselves. For the seven Precepts of the Noachides were originally the moral Law of all nations, and the first of them was to have but one supreme Lord God and not to alienate his worship; the second was not to profane his name; and the rest were to abstein from blood or homicide and from fornication, (that is from incest adultery and all unlawfull lusts,) and from theft and all injuries, and to be merciful even to bruit beasts, and to set up magistrates for putting those laws in execution. Whence came the moral Philosophy of the ancient Greeks.[123]

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[120]Newton, Keynes MS 7, p. 1.

[121]Newton, Keynes MS 7, p. 2.

[122]For an exposition of Newton's mortalism, see James E. Force, "The God of Abraham and Isaac (Newton)", in Force and Richard H. Popkin, eds., *The Books of Nature and Scripture: recent essays on natural philosophy, theology, and biblical criticism in the Netherlands of Spinoza's time and the British Isles of Newton's time* (Dordrecht: Kluwer, 1994), pp. 179-200.

[123]Newton, annotations to *Opticks* (1717), p. 382 (as shown in Frank Manuel, *Isaac Newton historian* [Cambridge, Massachusetts: The Belknap Press, 1963], plate 10). Newton's manuscript additions are underlined. The annotations almost certainly date from the time between the publication of the 1717 and 1721 English editions of the *Opticks*.

It is impossible to tell how seriously Newton contemplated placing these additional lines in print. What is certain is that they accurately reflect his views at that time.

The seven precepts of the Noachides are mentioned in "A short Scheme of the true Religion", where Newton also expresses his belief that these precepts were taught to the Gentiles later by "Socrates, Cicero, Confucius and other Philosophers, the Israelites by Moses and the Prophets and the Christians more fully by Christ and his Apostles".[124] For Newton, there is one true religion, or "law of righteousness and charity", and this was "dictated to the Christians by Christ, to the Jews by Moses and to all mankind by the light of reason".[125] "This was the religion of the first ages," Newton continues", till they forsook the right worship of the true God and turned aside to the worship of dead men and Idols". When this happened, "God gave them over to their lusts and passions for working all manner of unrighteousness".[126] The boldest language in the manuscript edition to the Babson copy is the expression "one supreme Lord God". There can be no question that Newton used this powerful expression in an antitrinitarian sense to refer to the Father only. In "A short Scheme of the true Religion" speaks of the need to "to acknowledge ~~the supreme God~~ one God infinite eternal omnipresent, omniscient, omnipotent, the creator of all things, most wise, most just, most good most holy; and to have no other Gods but him".[127] For Newton, ascribing full deity to any other being, including Christ, was a form of idolatry.[128]

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[124]Newton, Keynes MS 7, p. 3.

[125]Newton, Keynes MS 7, p. 3.

[126]Newton, Keynes MS 7, p. 3.

[127]Newton, Keynes MS 7, p. 2.

[128]Newton always used the expression "supreme God" in an antitrinitarian sense to refer to the Father. See Newton, Keynes MS 3, p. 27 ("one God" and "supreme God" written consecutively and then struck through); Newton, Keynes MS 7, p. 2; Newton, Yahuda MS 7.2j, f. 58v; Newton, Yahuda MS 14, f. 25r; Newton, Yahuda MS 15.5, f. 98r; Newton, Yahuda MS 41, f. 1v; Newton, Sotheby's 255.9, f. 2v (private collection); Newton, Fondation Martin Bodmer MS, chapter 5A, f. 9r. Newton uses the Latin equivalent "Deus summus" in the General Scholium (Newton, *Isaac Newton's Philosophiae naturalis principia mathematica: the third edition (1726) with variant readings*, ed. Alexandre Koyré and I. Bernard Cohen [Cambridge: Cambridge University Press, 1972], vol. II, p. 760). In Newton's "Irenicum",

In the end Newton, cautious as ever, settled on a radically truncated version of this manuscript addition in the third edition of 1721:

> And no doubt, if the Worship of false Gods had not blinded the Heathen, their moral Philosophy would have gone farther than to the four Cardinal Virtues; and instead of teaching the Transmigration of Souls, and to worship the Sun and Moon, and dead Heroes, they would have taught us to worship our true Author and Benefactor, as their Ancestors did under the Government of Noah and his Sons before they corrupted themselves.[129]

These sixteen words, which were retained in the fourth edition of 1730, summarise the content of Newton's manuscript writings on the original religion, including his monumental treatise "Theologiæ gentilis origines philosophicæ".[130] Although few knew what was behind these last words,[131] Newton could be content with the knowledge that he did.

As with the General Scholium, in Queries 28 and 31 Newton opens a window—ever so slightly—on the more explicit teachings of his private writings. Concerned about the ungodly and materialist corollaries of the excessive mechanism of Descartes and others, Newton was attempting to create a natural philosophy in which God and Spirit played a central role. Unlike Descartes, whose philosophy begins with God as an axiom, Newton's natural philosophy was meant to lead to God through the inductive method. Natural theology provided a link between Newton's conceptions of true natural philosophy and true religion. For Newton nature was not the result of blind chance, but

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the expression "supreme" is used on its own to refer to the Father in a passage that touches on many of the same themes as Keynes MS 7 (Newton, Keynes MS 3, p. 43).

[129]Newton, *Opticks* (1721), pp. 381-2. The additional sixteen words are underlined. This reading was retained in the fourth edition of 1730 (see Newton, *Opticks* [1730], pp. 405-6).

[130]Newton, Yahuda MS 16 and 41.

[131]In his memoirs of Newton's life, the antiquary William Stukeley records a meeting with Newton in late October or early November 1721 at which the former "read over to [him] that additional passage which he had inserted". This may be a reference to the added sixteen words; they certainly encapsulate a theme that would have been of interest to Stukeley (on Stukeley, see David Boyd Haycock, *William Stukeley: science, religion and archaeology in eighteenth-century Britain* [Woodbridge, Suffolk: The Boydell Press, 2002]).

the product of a God who is everywhere and whose sight is limited neither in a physical or cognitive sense. In both natural philosophy and religion, there are two ways: the way of right method and the way of corrupt method. Corrupt method in natural philosophy obfuscates as certainly as corrupt religion blinds its adherents. Just as fictitious hypotheses distracted natural philosophers from true causes, false gods led the heathen away from their true Creator. For Newton the heretic, these false gods included the Trinity. In writing about how idolatry had blinded the heathen, Newton may have had in mind a passage about spiritual blindness he quoted in his early treatise on the Apocalypse. In this passage, Jesus explains to his disciples why he spoke to the multitudes in parables: "because they seeing see not; and hearing they hear not, neither do they understand" (Matthew 13:13).[132] Only of the disciples did Jesus say: "But blessed are your eyes, for they see: and your ears, for they hear" (Matthew 13:16). As with Jesus in his parables, Newton did not embed higher truths in Queries 28 and 31 for the spiritually blind. These words were only for those with eyes to see the light of nature.

[132]Newton, Yahuda MS 1.1a, f. 2v.