RELIGION, MAGIC, AND THE ORIGINS OF SCIENCE IN EARLY MODERN ENGLAND

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Religion, Magic, and the Origins of Science in Early Modern England
I dedicate this volume, with love, to my daughter Isla, who was born and grew up while I was working on these studies.
Religion, Magic, and the Origins of Science in Early Modern England
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The articles in this volume, as in all others in the Variorum Collected Studies Series, have not been given a new, continuous pagination. In order to avoid confusion, and to facilitate their use where these same studies have been referred to elsewhere, the original pagination has been maintained wherever possible.

Each article has been given a Roman number in order of appearance, as listed in the Contents. This number is repeated on each page and is quoted in the index entries.
Arguments about the relationship between science and religion, and between science and magic have proved to be enduring aspects of the historiography of early modern science. The essays collected here contribute to one or another of these on-going debates; or more often to both, since historical realities seldom divide themselves along the neat lines that historians would wish to impose upon them. At a time when the newly conceived mechanical philosophy seemed to offer the best hope of replacing the increasingly moribund Aristotelianism of the universities, the nature of matter inevitably became a major focus of philosophical concern. By proposing to replace the hylomorphism of scholasticism with atomistic or corpuscularist theories, the new philosophers pinned their hopes on explaining all physical phenomena in terms of ‘matter in motion’. There were those, such as Galileo, Descartes, and Hobbes, who hoped to confine their physics purely to kinematics – so that the motions of bodies, and the interactions arising from their motions, were all that was required to explain any set of circumstances.\(^1\) For many other thinkers, however, especially those with a greater knowledge of, and practical expertise in, what we would now call chemical phenomena, a strictly mechanistic kinematics seemed unworkable. This led to an alternative view, in which bodies were invested with ‘active principles’ which enabled them to interact in ways that could not simply be reduced to their motions.

Broadly speaking, it was the occult nature of these supposed ‘active principles’ which ensured that the traditions of natural magic came to the fore in numerous versions of the new philosophy. But it is also evident that these attempts to develop new theories about the nature of matter and body mark one of the major aspects of the new sciences which Amos Funkenstein has seen as leading early modern natural philosophers to believe that traditional modes of theologizing had been rendered obsolete. Consequently, Funkenstein has persuasively argued, natural philosophers developed a ‘new and unique approach to matters divine’, and began to treat ‘theological issues at length’.\(^2\)

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God’s Providence. All natural philosophers seemed to be agreed that matter, according to its own nature, was passive and inert. If it could be shown that bodies had inherent principles of activity, therefore, it had to be supposed either that God had bestowed active principles upon these bodies, or that God had chosen some other way to make bodies appear to be active. It is the contention of a number of the papers gathered here that most thinkers simply assumed that God endowed active principles on matter, but that the Cambridge Platonists opted for an alternative view, which strictly maintained the passivity of matter and supposed that activity could not originate from bodies but derived from an all-pervasive immaterial Spirit of Nature – supposedly acting as the vicarious power of God in the world.3 In most of the articles that follow, therefore, a study of the role of occult qualities and other ideas from the natural magical tradition, leads us simultaneously into a study of the relationship between religion and natural philosophy.

The papers are presented in roughly chronological order with regard to their historical content. We begin with a study of William Gilbert’s pioneering study of magnetism, widely renowned as one of the first works of natural philosophy to rely heavily on the experimental method, the De magnete of 1600. Although it had been noticed before that Gilbert’s main aim in this work was to establish that the Earth itself was a giant magnet and therefore might be capable of spontaneously performing the kind of rotatory movements required by Copernican theory, I believe this was the first study to really emphasise this, and in so doing it was the first to bring out the importance of animism for Gilbert’s enterprise. Gilbert evidently did not feel the need to explore the religious implications of his new theory of an animate Earth, being content with rhetorical claims about the absurdity of denying the Earth a soul while granting souls to lowly creatures like insects and worms. The second essay features the interaction between religion and the new philosophy, in this case without any need to consider occult or magical notions. Sir Kenelm Digby

and his mentor, the secular priest Thomas White, made a remarkable but little known contribution to the Catholic Counter-Reformation during the English Interregnum, in which their version of the mechanical philosophy, and its implications for Christian dualism, was made to support a new version of Catholicism which made many concessions to Protestant belief, and which they hoped would win Protestants back to the Roman Church.

The third essay sets the agenda for the rest of the volume. It was in my paper on ‘Occult qualities and the experimental philosophy’ that I first tried to demonstrate that, contrary to the standard accounts, it was not Newton who re-introduced occult qualities back into natural philosophy after they had been vigorously excluded by Galileo, Descartes, and their respective followers. In a survey of English natural philosophers I showed that the strict mechanistic and kinematic approach of Galileo and Descartes (in which matter is completely passive) was only really adopted by Thomas Hobbes, and by the Cambridge Platonists, Henry More and Ralph Cudworth. Every other English natural philosopher of note accepted to a greater or lesser extent the presence of active principles in matter. It was while doing the research for this paper that I noticed the attack on Francis Glisson’s theory of active matter by the Cambridge Platonist Henry More. I expanded this into a separate study, which is included here (‘Medicine and pneumatology’). I was able to indicate here that the divide was not simply between natural philosophers on the one hand and theologians on the other, because I was able to show that the Presbyterian divine Richard Baxter supported Glisson. I followed this up with a broader survey of attitudes to the soul, in which it again became clear that the Cambridge Platonists differed in significant respects from the majority of their contemporary theologians. It emerged from this work that Henry More was opposed to the voluntarist theology that I had been led to believe was favoured by the leading experimental philosopher Robert Boyle. Accordingly, I examined the relations between More and Boyle and found that, far from being fellow-travellers helping to promote the mechanical philosophy in late seventeenth-century England (as was usually supposed), they were in fact seriously at odds with one another. The result was my essay on ‘Henry More versus Robert Boyle’.

Voluntarist theology plays a major role in a number of the studies here. Readers may be aware of Peter Harrison’s attempts to dismiss the historical significance of theological voluntarism on the grounds that it is nothing more than a misconception of historians. Peter Harrison, ‘Voluntarism and Early Modern Science’, History of Science 40 (2002), pp. 63–89; and ‘Was Newton a Voluntarist?’ in J.E. Force and Sarah Hutton (eds), Newton and Newtonianism (Dordrecht: Kluwer Academic, 2004), pp. 39–63. I have responded to these claims, and I hope re-asserted the historical importance of voluntarist theology to our understanding of early modern natural philosophy, in my ‘Voluntarist Theology at the Origins of Modern Science: A Response to Peter Harrison’, History of Science 47 (2009), pp. 79–113.
Robert Boyle and Robert Hooke are portrayed in the standard historiography of early modern science as dyed-in-the-wool mechanical philosophers. Having offered a somewhat different, but necessarily brief, treatment of them in my survey article on ‘Occult qualities and the experimental philosophy’, I felt that I should try to reinforce my claims at greater length. The articles on Boyle and his notion of ‘cosmical qualities’, and on Robert Hooke are intended, therefore, to show that the two leading natural philosophers in England before Newton both allowed principles of activity into their theories of matter. Although Newton has been recognised (by contemporaries such as Christiaan Huygens and G.W. Leibniz, and subsequently by R.S. Westfall and other Newton scholars) as re-introducing occult qualities into post-Cartesian natural philosophy, there has been a tendency to deny that he believed gravity acted at a distance. For modern historians and philosophers of science alike, action at a distance has been regarded as too occult, indeed too absurd, a notion for a great mind like Newton’s to accept. Given that Newton freely accepts action at a distance as a reality throughout his later work, I decided to try to understand how modern scholars could have so badly misunderstood him. The result was my article, reaffirming Newton’s acceptance of this quintessential occult notion, ‘Pray do not ascribe that notion to me’. Resistance to my argument still persists, however, and I have recently supplemented this early article with a more detailed study of Newton’s belief in action at a distance.

While working for so long on the use of natural magical traditions by early modern natural philosophers, it was inevitable that my thoughts should turn to one of the major problems in the historiography of magic – why did belief in magic among the learned go into decline towards the end of the seventeenth century, and the beginning of the eighteenth? The final essay in this collection offers my own contribution to this on-going debate.

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Animism and Empiricism:
Copernican Physics and the
Origins of William Gilbert’s
Experimental Method

In the second year of this journal’s run, way back in 1941, appeared Edgar Zilsel’s classic and still widely cited paper on The Origins of William Gilbert’s Experimental Method.1 Focusing on Gilbert’s De magnete of 1600, undoubtedly a seminal text in the history of the experimental method,2 Zilsel argued that Gilbert borrowed his methodology from elite craftsmen, artisans, and other manual workers involved in mining, smelting, smithing, compass making, navigation, sailing, and other activities which involved working with iron or with magnets.3 On its appearance the paper contributed to a growing and still continuing debate in the history of science about the relative importance of scholars and craftsmen in the origins of modern science. Although Zilsel’s general thesis has been critically evaluated in terms of that wider debate,4 his very specific claims about the

Thanks to Drs. Stephen Pumfrey and Katherine Neal for their help and encouragement.


3 See Zilsel, 24, but also 12-24. Zilsel makes the more general claim that modern science had its origin in “the experimenting manual workers of early capitalism” (24, 26-29), and in “The Sociological Roots of Science,” American Journal of Sociology, 47 (1942), 544-62.

role of elite craftsmen in providing Gilbert with a ready-made experimental method, have never been properly considered. This paper attempts to reassess Zilsel’s claims about the origin of Gilbert’s experimental method and, in so doing, to arrive at a richer understanding of what Gilbert was trying to do in De magnete and to suggest an alternative source for his experimentalism.

The first thing to note about Zilsel’s argument is that it had two strands. One of these pointed to actual experimental techniques used by Gilbert and showed that they can all be found in earlier writings on magnets. To be more specific, the techniques in question are to be found either in the thirteenth-century “Letter on the Magnet” written by Petrus Pergrinus or Pierre de Maricourt, first published in 1558, or in The Newe Attractive, a work on the magnetic compass written by a retired mariner, Robert Norman, first published in 1581 but reprinted three times before 1600. The second strand did not involve experiments at all, with one notable exception, but simply implied or suggested that Gilbert’s experimental techniques must have been inspired by miners and foundrymen, or navigators and instrument makers. The problem here, as others have objected, is that it is by no means clear that elite craftsmen were engaged in performing experiments in anything like the sense of the word required for the argument to cut any ice. For Zilsel, however, “we cannot doubt that many of [the miners and foundrymen of the period], stimulated to improvements by economic competition, were wont to try new techniques and to observe natural processes.” A few sentences later we are told that it is “obvious” that “among such manual labourers there were experimentalists, though experimentalists with practical aims only and without theoretical knowledge.”

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1 Zilsel, 27.
4 Zilsel, 14.
5 Ibid., 15.
The philosopher of science at this point might legitimately want to suggest that an experiment is not an experiment unless it is testing a theory, but we do not have to enter into such arguable niceties. We can see that there is something profoundly tendentious in Zilsel’s claims simply by reading on. At this point Zilsel mentioned the only experiment specifically referred to in this strand of his argumentation. Quoting Gilbert, Zilsel showed that Gilbert himself must have descended into a mine in order, as Zilsel says, “to verify the hypothesis” that the polarity of a magnet derives from the polarity of the earth:

We had a twenty pounds’ heavy loadstone dug and hauled out after having first observed and marked its ends in its vein. Then we put the stone in a wooden tub on water, so that it could turn freely. Immediately the surface which had looked to the North in the mine turned itself to the North on the water.

Zilsel did not make the absurd claim that Gilbert must have seen miners doing this kind of experiment, but he did all he could to imply that Gilbert’s experiment owed a great deal to his acquaintance with miners:

It is almost symbolic that Gilbert performed a laboratory experiment just after having left a pit and talked to miners. Of course Gilbert’s experiments were not plain copies of the trials of the miners and foundrymen. But his spirit of observing and experimenting was taken over not from scholars but from manual workers.

The suggestion that miners themselves might have taken it into their heads to see whether an extracted loadstone oriented itself in the same way as it had lain in its seam is not just unlikely but almost ludicrous, and so we have to wonder what other possible “trials of the miners” inspired Gilbert. If we cannot think of any, then we have to doubt the claim that Gilbert’s spirit of experimenting was taken from these manual workers.

Zilsel tried to bolster his rather weak position by claiming that in some cases Gilbert’s experiments “simply repeated the working processes of contemporary iron manufacture.” Referring to chapters nine to eleven of Book I of De magnete, Zilsel claimed that part of Gilbert’s “laboratory must have looked like a smithy,” because Gilbert tells us that “he heats the ore for hours in a furnace and melts it; then he hammers the product, puts it into a second furnace, and so on.” In fact Zilsel was conflating two different parts of Gilbert’s account here. In chapter

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11 Zilsel, 15, translation differing slightly from Mottelay’s (De magnete, Bk. III, ch. 4, 184).
12 Ibid.
nine Gilbert told the reader that if he were to roast some pieces of stony iron ore “in a moderate fire” for some ten or twelve hours and then allow them to cool in a north-south orientation, the stones would now be attracted to a loadstone, even though they were not before (due to their excessive stoniness). In chapter eleven Gilbert described the process of making wrought iron, which “as everyone knows” is attracted to a loadstone, but he did not suggest that he had done this himself. During smelting, we are told, “the metal flows out ... and forms a great long mass, which under the blows of a large hammer is cut into pieces: from these, after being reduced in another furnace and again put on the anvil, the workmen form cubical masses, or more usually bars, which are sold to merchants and blacksmiths: from these blocks or bars are everywhere made in smiths’ shops various implements.” It is perfectly evident that Gilbert was here telling his scholarly readership how wrought iron is made (by workmen); there is no suggestion that he has done it himself. It is one thing to roast some stones in a moderate fire, and quite another to have a furnace capable of heating iron ore to “very great heat” for eight to twelve hours and then to be able to contrive for the metal to pour out to form “a great long mass,” and so on.

If Zilsel’s attempts to suggest in fairly general terms that Gilbert borrowed his experimental method from artisans and craftsmen remain unsatisfactory, maybe we should look to the other strand of his argument, where he considered the very specific influences of Pierre De Maricourt and Robert Norman. There can be no doubt of the influence of Pierre’s “Epistle on the Magnet” on Gilbert. As Zilsel pointed out, Gilbert’s method of determining the poles of magnets and his technique of floating magnets in water on wooden (or in Gilbert’s case, cork) supports to enable them to move freely, are identical to Pierre’s techniques. But Zilsel was aware that this thirteenth-century philosopher presented a difficulty for his case. The fact that Pierre was already performing experiments centuries before sits uneasily with Zilsel’s claim that “experimental science could not come into existence so long as liberal and mechanical arts were kept separate by the contempt for manual labor.” Zilsel did not allow this to detain him long. Pierre de Maricourt is simply seen as a great precursor who did not allow his interests to be hampered by the “social prejudices” of his day. “We do not know,” Zilsel wrote, “where Petrus’s freedom from bias [against manual labor] originates,” but his attitude merely serves to confirm “the importance of manual labor and the mechanical arts for the history of science.” But as we shall see, the significance of Pierre lies elsewhere.

13 See De magnete, Bk. I, ch. 10, 48; also 47. Cf. Zilsel, 15, and 14 where, citing the same passage, he writes that Gilbert “describes how he himself manufactures the wrought iron he needs for his experiments.”
14 Zilsel, 12; and see also Roller, op. cit., 39-42.
15 Zilsel, 29.
16 Zilsel, 30.
Zilsel discusses at some length the other undeniable influence upon Gilbert, the retired navigator, Robert Norman, and he does seem to provide an undeniable case of an elite craftsman who really was performing experiments in an effort to understand the behavior of magnets. Like Pierre de Maricourt, Norman floated magnets on water in specially prepared experimental vessels or suspended them on threads. Gilbert used both these techniques. Norman weighed iron before and after magnetizing it to determine that the magnetic virtue is imponderable, and he showed experimentally that a floating magnet merely turns toward the pole but is not attracted towards it. Again, Gilbert repeated both of these experiments and gave due acknowledgment to Norman for the second. Gilbert clearly knew Norman’s *Newe Attractive*, therefore, and recognized its importance. In the opening chapter of *De magnete* Gilbert mentioned Norman as a “skilled navigator and ingenious artificer, who first discovered the dip of the magnetic needle.” Since the phenomenon of magnetic dip was to play a major role in Gilbert’s own theory of magnetism, it is fitting that he should acknowledge Norman in this way.

If Gilbert was indebted to Norman, it would seem that Zilsel was even more beholden. “Robert Norman,” Zilsel wrote, “is of great importance for our problem.” Even if the supposed influence of miners and foundrymen on Gilbert’s experimental method is discounted and even if the relevance of Pierre de Maricourt to an account about the role of economic forces in stimulating the Scientific Revolution is rescinded, Norman remains as an undeniable element in Zilsel’s case. It was crucially important to Zilsel that his readers should recognize that “This remarkable man who, twenty five years before Galileo’s first publication, speaks of the ‘incredible delight’ of experimental discovery, was a craftsman.” For Zilsel, Norman, “the experimenting compass-maker,” was “even nearer than Gilbert to the sober objectivity of modern natural science.”

While Zilsel believed that there was a significant historical “problem” in trying to understand how a learned scholar like Gilbert might have come up with the experimental method, he perceived no such problem arising from the fact that Norman relied upon the experimental method. After all, Norman was a manual worker, one who was used to the hands-on approach of the experimentalist. He was a practical man trying to earn his living and as such can be seen, quite unproblematically, as one of those “experimenting manual workers of early capitalism.”

Those of us who do not share Zilsel’s Marxist economic determinism and his naïve view of the nature of experimentation might wish to differ. After all, as

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17 *De magnete*, Bk. I, ch. 1, 15. See Zilsel, 19.
18 Zilsel, 23. The “incredible delight” is attributed by Norman (*Newe Attractive*, Epistle Dedicatory, sig. Aii’) not to himself but to Archimedes, Pythagoras and “sundrie others, that are mentioned in aucthours.”
19 Zilsel, 24; and 6, 12, 23, on the origins of Gilbert’s method, and therefore of modern science in general.
we have already suggested, it would be completely unwarranted to regard Norman as just one of many artisan experimenters. The experimental research he carried out for his *Newe Attractive* was highly unusual, not the routine kind of thing that any compass maker or navigator might have been expected to do. Where then might Norman have received a stimulus to develop his experimental techniques? In fact Robert Norman informs us himself (although Zilsel seems to have overlooked it). It arises from Norman’s accidental discovery of the phenomenon of magnetic dip:

\[
\text{Havyn made many and divers compasses and using alwayes to finish and ende them, before I touched the needle, I found continually, that after I had touched the Irons with the Stone, that presently the North poinct thereof would bende or } \text{Decline} \text{ downwards under the Horizon in some quantitie: in so much that to the Flye of the Compasse, which before was made equall, I was stil constrained to put some small peece of Ware in the South part thereof, to counterpoise this } \text{Declining}, \text{ and to make it equall againe.}^{20}
\]

What this means is that a carefully balanced iron needle, made for the compass, would no longer pivot on the level once it had been magnetized by rubbing with a loadstone. After magnetization the needle would now dip down, as though unbalanced by the act of magnetizing.

Norman tells us that, for a long time, he paid no special attention to this effect: “Whiche effect havynge many tymes passed my handes, without any great regard therunto, as ignorant of any suche propertie in the Stone, and not before havynge heard nor read of any such matter.”^{21} The day came, however, when he was commissioned to make a compass with a needle of “sixe ynches long.” This time, he tried to correct the unbalancing by cutting some of the North end of the needle away, but he cut it too short and spoiled the whole needle. Somewhat enraged by this (“stroken into some choler”), Norman tells us that he now decided to try to understand this effect. We can see here, then, that Zilsel is partly right: Norman certainly was stimulated to understand this natural effect by economic factors. But if economic necessity was the Mother of Norman’s invention, it also had some potential fathers from (for Zilsel anyway) an unexpected source:

\[
\text{I applied my self to seeke further into this effect, and makyng certayne learned and expert men, my freendes, acquainted in this matter, they advised me to frame some Instrument, to make some exacte triall, how much the Needle touched with the Stone would Decline, or what great-}
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20 *New Attractive*, 8.
21 *Ibid*. 
est Angle it would make with the plane of the Horizon. Whereupon I made diligent proofes, the maner whereof is shewed in the Chapter followyng.22

The artisan Robert Norman developed his experimental method, therefore, because some learned experts told him that was the right way to go about it.

In keeping with his thesis that modern experimental science owes its origins to the breakdown of the barriers between craftsmen and scholars, Zilsel sees Gilbert as the “first academically trained scholar who dared to adopt the experimental method from the superior craftsmen and to communicate the results in a book not to helmsmen and to mechanics but to the learned public.”23 Because of his understanding of the scientific importance of experiment (which he supposedly gleaned from his personal knowledge of various craftsmen and their work), Gilbert was able to help make manual experimental work respectable among the ranks of the educated. Gilbert was seen by Zilsel, therefore, to be in the vanguard of those intellectuals who, “with the advancement of early capitalistic society,” rebelled against both Scholasticism and humanism and began to make contacts with elite craftsmen.24

Zilsel’s slant on Gilbert and what he was trying to do seriously affected the way Zilsel presented the De magnete and its purpose. Zilsel gave the distinct impression that the De magnete was a compendium of knowledge about iron, loadstones, and magnetism, presented to intellectuals for entirely pragmatic reasons. For Zilsel the De magnete was “nearer to a technological than to a physical work of our time,” and he famously broke down the subject matter of the De magnete into its constituent parts: only 40% of the book deals with physical experiments, he wrote, while 25% deals with nautical instruments and navigation, 10% is concerned with mining, smelting, and fashioning of iron, and so on.25 After showing Gilbert’s knowledge of mining and metallurgy, Zilsel insisted that these are the “mining and metallurgy of rapidly advancing early capitalism.” Similarly, Gilbert’s interest in navigation was linked to the circumnavigations of the globe and European expansion.26

Zilsel was so bound up with his own account of what De magnete was all about that the real and very obvious purpose of Gilbert’s book was hardly alluded to at all. Indeed, difficult as it is to believe of anyone who had read the book so closely, it looks very much as though Zilsel completely missed the point.

22 New Attractive, 9.
23 Zilsel, 28.
24 Zilsel, 27.
26 Zilsel, 14, and 25, where Zilsel (note 34) suggests the importance of military engineering to Gilbert as well.
But Gilbert’s point is clearly spelled out, as was usual in those days, by the full title of his book: *On the magnet and magnetic bodies, and on the great earthly magnet*. A glance at the contents pages will show that the whole argument of the book culminates in the sixth and final part, where the first of nine chapters speaks “Of the globe of the earth as a great loadstone.” Certainly, Zilsel was aware of this aspect of Gilbert’s achievement, he knew that “Gilbert was the first to conceive of the earth as a large magnet,” but he dismissed this aspect of Gilbert’s work as a lucky guess: “the resemblance of his magnetic philosophy to modern science is merely a matter of chance.”

Zilsel’s failure to see the importance of Gilbert’s discovery seems to be confirmed by the fact that he failed to notice its connection with the Copernican theory about the motion of the earth. Zilsel noted Gilbert’s support for the Copernican theory, but only incidentally as he detailed Gilbert’s knowledge of contemporary authors. The mathematician Edward Wright, who wrote a “Laudatory address concerning these books on magnetism” prefixed to Gilbert’s book, made it perfectly plain, however: “no one, I do believe, ever gave more certain demonstrations” of the spherical motion of the earth.

In fact the whole point of *De magnete* was to offer a solution to a crucial problem for Copernican theory. In his *De revolutionibus orbium coelestium* of 1543 Copernicus effectively left unanswered the question as to how the earth might be able to move and keep on moving. According to Aristotelian physics, of course, the continued motion of the earth was as absurd a proposition as it was possible to imagine. Although Copernicus tried to show the inadequacy of the standard arguments against the motion of the earth, enabling him to conclude that “nothing prevents the earth from moving,” he did not follow this up with an argument as to what made the earth move.

As Robert S. Westman has shown, Copernicus tried to introduce a new epistemology of natural science in which the dictates of mathematics were taken to establish the way things are. According to the prevailing tradition, it was the natural philosopher who established the truth of things, and he did so by explaining how the phenomena in question took place. In the case of astronomical phenomena that explanation would be couched in terms of Aristotelian physics. Mathematics was regarded, like logic, as an instrument by which certain kinds

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27 Zilsel, 5.
28 Zilsel, 9. See *De magnete*, Bk. VI, ch. 3, 318.
of truth claims could be analyzed and tested, but it was not held to explain anything. In what Westman has seen as an attempt to bring about a major change in both the intellectual and social role of the astronomer, Copernicus professed to be content with the fact that his mathematics told him that the earth must be in motion, as one of the planets, around the stationary sun.31

We can see this, for example, in his discussion of the order of the planets. In the Ptolemaic system the order of the planets (outward from the earth) could be established only by convention. Copernicus’s theory changed this, making it possible to establish the order of planets according to the geometry of the system. For Copernicus this was sufficient proof that his system was true. Noticing that the “grand circle” between the convexity of the sphere of Venus and the concavity of the sphere of Mars, all the planets being centered on the sun, was sufficient to contain the earth and the moon, Copernicus boldly declared: “Hence I feel no shame in asserting that this whole region engirdled by the moon, and the centre of the earth, traverse this grand circle amid the rest of the planets in an annual revolution around the sun.”32 Copernicus’s lack of embarrassment, however, was not sufficient to convince natural philosophers, who continued to demand a physical explanation of the earth’s putative motion. Since Copernicus died the same year that his book appeared on the public stage, this problem was left as a legacy to all would-be Copernicans.33

William Gilbert, evidently one of the earliest committed Copernicans, believed he had the answer. Magnets have the ability to rotate spontaneously, and the earth is a giant magnet; therefore, the earth has the power to rotate spontaneously. The whole of De magnete was dedicated to showing the truth of this.

Although the first part, Book I, sets out to provide what, for its day, was a typically encyclopaedic natural history of the loadstone and of iron, it ends with a chapter declaring “That the terrestrial globe is magnetic and is a loadstone; and, just as in our hands the loadstone possesses all the primary powers (forces) of the earth, so the earth by reason of the same potencies lies ever in the same direction in the universe.”34 Book II begins with a series of chapters on magnetic

33 Such thinkers were called “philosophizing astronomers” by Johannes Kepler (see Westman, op. cit., p. 117), and included Thomas Digges, Christopher Rothmann, Michael Maestlin, Kepler, and Galileo; Gilbert’s name should also be added to this list.
movements, but soon compares the earth to magnets, with chapters on “the earth’s magnetic meridians” (ch. 10), “the magnetic horizon” (ch. 12), “Of the magnetic axis and poles” (ch. 13) and so on. In this book the reason for Gilbert’s choice of spherical magnets in his experiments becomes apparent. By showing how a spherical loadstone behaves, or how small iron needles behave in relation to the spherical surface of the loadstone, Gilbert is easily able to draw analogies with the giant magnet of the earth and with the behavior of iron needles, or compass needles, in relation to the earth. “All the experiments that are made on the terrella, to show how magnetic bodies conform themselves to it,” Gilbert wrote, “may ... be shown on the body of the earth.”

This, incidentally, is something else which Zilsel failed to understand. “In all his experiments,” Zilsel pointed out, “he [Gilbert] uses spherical loadstones, although he himself knows that bar-like magnets are more effective.” Zilsel’s bafflement is evident from his subsequent, inconsistent, speculation: “He calls them ‘little earths’ (terrellae [Bk] I, [ch.] 3) and presumably clings to the medieval shape of his magnets because he believes in a metaphysical connection of spherical form and magnetism.” It is difficult to imagine how Gilbert might have recognized the greater attracting power of bar magnets and yet believe that magnetism was dependent upon a spherical form. Later Zilsel blamed the influence of Pierre De Maricourt for Gilbert’s “rather inexpedient” choice of shape for his experimental magnets. In fact Pierre deliberately used spherical magnets to imitate the shape of the starry vault, since he believed that magnets orientated themselves to the heavenly poles. Given that Gilbert rejected this belief and wanted to establish empirically that magnets orientated themselves with respect to the magnetic poles of the earth, Gilbert’s choice of spherical magnets, far from being inexpedient, was even more appropriate than it was for Pierre. Zilsel must have been in the same uncomprehending mood at the point where he came closest to stumbling over what the De magnete was all about:

How near his [Gilbert’s] “magnetic philosophy” still is to medieval vitalism is revealed by the fact that he believes in a metaphysical correlation of magnetism and rotation. He speaks of the “magnetic rotation” of the Terrestrial globe ([Bk] VI, [ch.] 3, p. 214 [317]), and would like to accept the statement of Pierre de Maricourt that a spherical magnet rotates continuously by itself, were it not for his conscience as a cautious experimentalist. He reproduces Pierre’s statement and adds (VI, 4, p. 223 [332]): “until now we have not succeeded in seeing this. We even doubt this movement because of the stone’s weight and because the whole
William Gilbert’s Experimental Method

earth moves by itself, as it is moved by the other stars also. That does not hold proportionally of some part [the terrella].”38

Ironically, in the accompanying footnote, Zilsel wrote that “In order to understand Gilbert’s argument we have to realize that he was among the earliest adherents of Copernicus in England and was already convinced of the rotation of the earth.” Certainly Gilbert himself was already convinced of the rotation of the earth, but he was trying to convince his contemporaries. According to Zilsel, Piere’s claim that a terrella undergoes a diurnal rotation was rejected by Gilbert because he, unlike Pierre, believed in the rotation of the earth. In fact Gilbert was trying to offer a reason why his experimental efforts to reproduce diurnal motion of a terrella had repeatedly failed. Zilsel thought that Gilbert wanted this experiment of Pierre’s to be repeatable simply because of his belief in a “metaphysical correlation of magnetism and rotation,” but his Copernicanism overcomes his naïve medieval vitalism and led him to reject it. Zilsel failed to realize that Gilbert wanted the experiment to work because it would have clinched his argument that the earth rotates because it is a giant loadstone.

Books I and II of De magnete make it quite clear that the major concern is to draw an analogy between the loadstone and the earth itself, and so it is with the rest of the text. Book III begins with a consideration of the causes of magnetic motions and goes on to say that “Earth, the mother of all, hath these causes shut up in her recesses: all magnetic movements are to be considered with respect to her law, position, constitution, verticity, poles, equator, horizon, meridians, centre, periphery, diameter, and to the form of her whole inward substance.”39 Book IV is concerned with magnetic “variation,” which is Gilbert’s term for the deviation of the compass needle from true north and so is entirely concerned with discussion of the earth and the behavior of compasses in different parts of the globe. Book V is concerned with magnetic dip, the phenomenon discovered accidentally by Robert Norman, and again is largely concerned with the behavior of compass needles in different parts of the globe. Book VI finally spells out the inescapable conclusion of the foregoing books, that the earth is a giant loadstone and that, like magnets, it is capable of spontaneous circular movement about its axis and of maintaining itself in a particular orientation.

In many respects it is the material in Book V, explaining the phenomenon of magnetic dip, which completes Gilbert’s argument that the earth is a giant magnetic sphere. It is also the area where Gilbert approaches closest to the work of

38 Zilsel, 5-6, translation from De magnete, differing slightly from that of Mottelay, De magnete, Bk. VI, ch. 4, 332.
39 De magnete, Bk. III, ch. 1, 179-80; and see Freudenthal, op. cit.
Robert Norman and where Zilsel believed the image of Gilbert’s originality was most “impaired.”

We have already heard Norman’s account in the *Newe Attractive* as to how he came to investigate magnetic dip—the mysterious declination from the level position of the carefully balanced iron needle, after it had been magnetized. Having been advised by some learned friends to make an instrument capable of making an “exacte triall” of the extent to which the needle would decline, Norman readily put his compass-making skills to good use. Pivoting an iron pointer so that it could move in a vertical instead of a horizontal plane, against a vertical round plate “like an Astrolabe,” divided exactly into 360 parts, Norman was quickly able to establish that at London the needle would dip to 71 degrees and 50 minutes below the horizon.

After showing that a floating magnetized needle (buoyed up by cork) merely altered its inclination but did not move from its place, Norman concluded that the needle was orientating itself to what he called a “point Respective” and was not physically drawn to a “point attractive.” The implication of this, as Norman recognized, was that the behavior of the magnetized needle could not easily be attributed to some external drawing power but must be in the needle itself (presumably bestowed upon it by the magnet). As for the “point Respective” itself, Norman was only able to say that it must lie along a line declining at 71° 50’ below the horizon at London. It was impossible to say precisely where along that line the respective point was until observations of magnetic dip in other parts of the globe allowed a triangulation. Nevertheless, Norman clearly states his belief that the point respective is in the body of the earth and not in heaven.

In his “Epistle on the Magnet” Pierre de Maricourt had already described something very like the kind of triangulation exercise which Norman advocated, but on the surface of a magnetic terrella. In order to determine the poles of a terrella, Pierre wrote, one should allow slender iron needles to be picked up by the stone, and then draw a line along the length of the needle. After repeating this procedure a number of times, the various lines will be seen to converge in two points: “Know then that one is north and the other south.” According to Pierre, however, the accuracy of this can be checked:

> In order, therefore, that you may determine one point [pole] on the stone exactly, break from the needle or iron a little piece which shall be oblong, and about as long as two finger nails and place it on the spot at

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40 Zilsel, 25.
41 *Newe Attractive*, 9-10. In fact the text says the astrolabe-like plate should be divided into 160 parts, but this is obviously a typographical error.
42 *Newe Attractive*, 12-15, also 18.
43 *Newe Attractive*, 17, 18.
which, as already stated, the point has been found, and if it stands perpendicular to the stone, there is no doubt that the place sought is there, if not move it about until it does stand perpendicular.\footnote{Harradon, 7-8.}

Pierre’s technique relies upon the fact that a small pointer on the surface of the magnetic sphere will point straight to the magnetic pole (always located not on the surface but at a point just below the surface of the sphere) at an appropriately sloping angle until it is directly over the pole, in which case it will point straight in toward the center of the sphere. At this point, in Norman’s terms, the angle of dip is 90° from the horizontal.

We know that Gilbert read both Norman and Pierre de Maricourt, and so it is hardly surprising that we see him putting them both together in the way that I have here. Whereas Pierre was concerned only to determine the position of the pole, Gilbert used his terrellae and small needles to demonstrate how the dip of the needle in Norman’s “Dip Instrument” can be imitated by moving small needles over the surface of a magnetic sphere (see illustration).\footnote{See \textit{De magnete}, 275-304.} The conclusion then seems hard to deny: the dip of a compass needle, or a needle in a “dip instrument,” is due to the fact that the earth itself is a giant spherical lodestone. At London the needle points directly to the north magnetic pole somewhere beneath the surface of the earth near the geographic north pole. It does so by pointing straight into the earth at an angle of 71° 50’. Take the instrument further north and the inclination will be steeper until, at the magnetic pole, it will be pointing straight down towards the center of the earth.

Norman freely admitted that he did not know why the magnetic needle pointed to the point respective, and although Pierre de Maricourt knew why his needles pointed straight down at the poles of his terrellae, he had no awareness of a corresponding geomagnetic dip. It took Gilbert to put the two together and to realize that the earth was a great magnet. Questions of originality are endlessly debatable, but we should be wary of allowing hindsight to distort our judgment. It seems to me that Gilbert’s originality lay not just in the fact that he realized the magnetic nature of the earth but also that he saw that it could be clearly demonstrated using the experimental techniques of Pierre de Maricourt and the phenomenon of dip. Furthermore, he had the boldness to believe that this could lead to a solution to the major problem of Copernican physics—how the earth moves. Although this last aspect of Gilbert’s thinking was mistaken, it was a powerful and justly influential idea, which was taken up and extended by other early
Gilbert’s diagram showing how the “dip” of a small magnetized needle varies over the surface of a terrella, *De magnete*, Bk. V, ch. 2, 285. Since the convention of orienting maps with the north/south axis vertical was only just being established at this time (J. B. Harley and David Woodward, “Concluding Remarks,” *The History of Cartography*, ed. J. B. Harley and D. Woodward [Chicago, 1987], I, 506), and there was no corresponding convention on depictions of magnets, Gilbert, like the printers of Pierre De Maricourt’s *De magnete* (Augsburg, 1558), chose a horizontal depiction of the north/south axis.

Copernicans, including even Galileo and Kepler. To deny Gilbert’s originality is surely to misunderstand what he was trying to do.

There can be no doubt of the importance of magnetic dip for Gilbert’s philosophy. As he wrote in the opening words of Book V, “We come at last to that fine experiment, that wonderful movement of magnetic bodies as they dip be-

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47 Zilsel has not been alone in denying Gilbert’s originality. For J. L. Heilbron, *Electricity in the 17th and 18th Centuries: A Study of Early Modern Physics* (Berkeley, 1979), 169, Gilbert is best seen as a “moderate peripatetic and not above plagiarizing those he criticizes” (a view opposed by Freudenthal, *op. cit.*).
neath the horizon in virtue of their natural verticity; after we have mastered this, the wondrous combination, harmony and concordant interaction of the earth and the loadstone (or magnetized iron), being made manifest by our theory, stand revealed."\(^{48}\) It should be noted, then, that Gilbert’s primary concern was to demonstrate that the earth is a giant loadstone: “This motion [of dip] we have so illustrated and demonstrated with many experiments, and purpose in what follows so to point out the causes and reasons, that no one endowed with reason and intelligence may justly contemn, or refute, or dispute our chief magnetic principles.”\(^{49}\) Certainly, Gilbert took the trouble to show the pragmatic relevance of the phenomenon of dip for navigators. Unfortunately, the use of the dip instrument together with proposed maritime tables of dip merely provided an alternative way of determining one’s latitude; they provided no help with longitude, the real navigational problem at this time.\(^{50}\) In any case this concern is merely incidental. It is perfectly clear that the magnetic principles Gilbert mentioned referred to the nature of the earth and its inherent motions.\(^{51}\)

Having established the magnetic nature of the earth by his experiments, Gilbert feels justified in claiming that the earth’s ability to move itself with a circular motion “is proved by its parts, which, when separated from the whole, do not simply travel in a right line, as the Peripatetics taught, but rotate also.” The natural movements of the whole and the parts are alike, Gilbert claims, “hence, since the parts move in a circle, the whole, too, hath the power of circular motion.”\(^{52}\) The conclusion is offered as undeniable: “The earth therefore rotates.”\(^{53}\) As Edward Wright declared in his “Laudatory Address,” no one else “ever gave more certain demonstrations” of the motion of the earth. In 1600 it was certainly a reasonable claim to make.

I hope I have said enough to throw serious doubt upon Zilsel’s claim that Gilbert took the experimental method from superior craftsmen. The question remains, where did Gilbert get the inspiration for his experimental approach?

In a very real sense I do not think that we have to look much farther than Pierre de Maricourt’s “Epistle on the Magnet,” published for the first time not many years before, in 1558. Pierre’s epistle is short and does not contain many experiments, but all the basic techniques which Gilbert uses can be found there.

\(^{48}\) *De magnete*, Bk. V, ch. 1, 275. See also Bk. VI, ch. 1, 314: “one experiment [magnetic dip] reveals plainly the grand magnetic nature of the earth...”

\(^{49}\) Ibid.


\(^{51}\) Freudenthal’s analysis of Gilbert’s attempts to develop a new theory of matter in support of his new physics and cosmology supports the argument that if Gilbert’s main concern was the practical uses of iron and magnets, he would not need to bother himself about such niceties.

\(^{52}\) *De magnete*, Bk. VI, ch. 4, 331.

\(^{53}\) *De magnete*, Bk. VI, ch. 4, 333.
Moreover, Pierre’s epistle is very much concerned with showing the cosmic significance of magnets and magnetism. Although Gilbert was to differ from Pierre, the Frenchman’s suggestions that the loadstone “bears in itself the similitude of the heavens” and that “it is from the poles of the world that the poles of the magnet receive their virtue,” can easily be seen as the kind of thinking about magnets that Gilbert might have found stimulating and inspirational.  

Zilsel, as we have seen, tried to present Pierre as a thinker ahead of his time, one who rejected the contemporary bias against manual labor and who, like Gilbert, paid attention to the experimenting of craftsmen. Certainly Pierre de Maricourt had a reputation for being, as even a renowned experimentalist like Roger Bacon acknowledged, “a master of experiment.” Pierre himself extolled the importance of the hands-on approach in his epistle:

> the investigator in this subject ... must himself be very diligent in handicraft also, in order that through the operation of this stone he may know wonderful effects. For by his carefulness he will be able to correct an error which in an age he could not possibly do by any means of his knowledge of nature and mathematics, if he lacked carefulness in use of hands.

But Pierre was not writing here as a man out of his time. He was simply writing as a natural magician. “For in occult operations,” Pierre explained to his correspondent, “we investigate many things by manual industry, and in general without it we are unable to bring anything to completion.” Indeed, Pierre wrote in the opening chapter of his letter that he might have dealt with even more occult aspects of the loadstone but that here he intended to confine himself to the magnet’s more manifest properties, “on the ground that this teaching will form part of a Tract, in which we shall show how to construct physical instruments.” The more occult properties Pierre had in mind required knowledge of “the art of engraving stones,” by which, presumably, he meant some sort of talismanic knowledge. But he immediately went on to say that even the comparatively manifest properties of magnets which he intends to consider in this letter are only mani-

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54 Harradon, 7 and 11.
55 Harradon, 4.
56 Harradon, 6.
fest to “astrologers” and “naturalists” but will be regarded by the common people as “illusions and phantasms, because they are secrets to the layman.”

The point is, then, that Pierre de Maricourt was a natural magician, and the use of the experimental method was a commonplace within that tradition. Although many historians of science seem to prefer to ignore what they anachronistically regard as an embarrassing aspect of science’s origins, the links between magic and experimentalism have been impossible to deny ever since the appearance of Lynn Thorndike’s magisterial study of the history of magic. Devoted to establishing the proposition “that magic and experimental science have been connected in their development; that magicians were perhaps the first to experiment; and that the history of both magic and experimental science can be better understood by studying them together,” Thorndike’s enterprise can hardly be said to have suffered from a lack of evidence. Even Edgar Zilsel acknowledged the links between magic and experiment, though he mentioned it only to dismiss it. The prejudice against manual labor, he wrote, “did not prevent the experiments of the alchemists.” Alchemy was made “respectable by the charm of both magic and gold,” so that even well-bred people may practice it “as a hobby.”

There would seem to be a prima facie case for suggesting that Gilbert derived his experimental method not from elite craftsmen but from the well-known magical tradition. This is certainly the impression that Gilbert himself gives in the opening words to De magnete in his preface:

Since in the discovery of secret things and in the investigation of hidden causes, stronger reasons are obtained from sure experiments and demonstrated arguments than from probable conjectures and the opinions of philosophical speculators of the common sort; therefore to the end that the noble substance of the great loadstone, our common mother (the earth), still quite unknown, and also the forces extraordinary and exalted of this globe may the better be understood, we have decided first to begin with the common stony and ferruginous matter, and magnetic bodies, and the parts of the earth that we may handle and perceive with the senses; then to proceed with plain magnetic experiments, and to penetrate to the inner parts of the earth.

58 Harradon, 6.
60 Zilsel, 26.
61 De magnete, “Author’s Preface,” xlvii.
These do not seem to be the words of a man introducing an unheard-of procedure to his scholarly readership. Just as he seemed to expect his readers to know what he meant by “speculators of the common sort,” so he anticipated no difficulty in their seeing that, if you are studying occult phenomena (and magnets were always regarded as the supreme occult objects), then you use experiments. Later on in his preface Gilbert referred to his book as presenting “a new style of philosophizing,” but it is clear that what Gilbert claimed as new is the content—“these foundations of magnetic science.” Similarly, two paragraphs later Gilbert refers to his natural philosophy of magnetic forces as “almost a new thing, unheard-of before.”62 Nowhere does Gilbert ever make any corresponding claims about the originality of his experimental method. Given this and the fact that Robert Norman told us he was advised to proceed experimentally by some learned friends, it seems unwise to assent to Zilsel’s claim that experimental science could not have come into existence before the barrier between scholars and craftsmen was demolished.63

There are other reasons for seeing Gilbert as a writer in the magical tradition. Thanks to the work of Gad Freudenthal we now know of Gilbert’s awareness of Paracelsian alchemical theory and his eclectic use of it in developing his own mineralogical theory to support his magnetic philosophy.64 But we do not need to rely on such penetrating scholarly excavations, for if there is a patently obvious feature of Gilbert’s work apart from his experimentalism, it is his animism. For Gilbert the earth is not only a giant loadstone, it is a giant animate creature. Indeed, it is its magnetic ability to move itself which testifies to its animate nature.65

Rejecting the traditional Aristotelian position, in which the earth was held to be “imperfect, dead, inanimate, and subject to decay,” Gilbert insisted that just as the motions of the heavenly bodies testified to their animate nature, so the magnetic motions of the earth revealed it to be animated. Gilbert even suggested that the earth’s magnetic soul was in many ways superior to the human soul, which can be deceived by the senses:

The earth’s magnetic force and the formate soul or animate form of the globes, that are without senses, but without error and without the injuries of ills and diseases, exert an unending action, quick, definite, con-

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62 De magnete, “Author’s Preface,” xlix, and I. J. L. Heilbron, op. cit., 169, has noted with some contempt what he calls Gilbert’s advocacy of his own originality, but in no case does Gilbert refer to his experimental method in these terms.
63 Zilsel, 28.
64 Freudenthal, op. cit., 24-28.
stant, directive, motive, imperant, harmonious, through the whole mass of matter.... Yet these movements in nature’s founts are not produced by thoughts or reasonings or conjectures like human acts, which are contingent, imperfect and indeterminate, but connate in them are reason, knowledge, science, judgment....

It is the very obvious combination of animism and empiricism in Gilbert’s *De magnete* which has caused different historians to make conflicting claims as to his significance in the history of science. Because of the subsequent extreme divergence of experimentalism and animism in western culture, historians seem to have had difficulty in recognizing the simple fact that Gilbert worked at a time before that divergence had begun, when animistic thinking and the experimental method were both to be found in the tradition of natural magic. In the accounts of different historians, as Mary Hesse has observed, different pictures of Gilbert have been made to take shape. But they are distorted pictures, caused by a failure properly to locate Gilbert’s thought in its own context. Wishing to see Gilbert as a modern thinker, Zilsel was forced to accept that it was “not easy to draw the picture of Gilbert’s scientific attitude correctly.” Although Gilbert was “usually as critical minded as a modern experimentalist,” his animism, Zilsel believed, showed “the strongly emotional background of the idea of the maternal earth.” Zilsel evidently could not see the possibility of critical animism, even though, in studying Gilbert, he was studying one of the greatest critical animists who ever lived.

What allows us to call Gilbert’s animism “critical” is the very fact that he performed experiments in order to establish the extent and the precise nature of the magnet’s animation. In so doing, Gilbert should not be said to have been applying an inappropriately “scientific” method to a figment of the “occult mentality.” He was simply drawing upon the common procedures, “manual industry” as Pierre de Maricourt called it, of the tradition of natural magic for understanding “occult operations.”

Far from being contradictory strands in his work, Gilbert’s animism and empiricism were entirely complementary. His experiments enabled him to establish, at least to his own satisfaction, that there is a magnetic soul which enables magnets to move themselves; and this newly established animism in turn allowed Gilbert to clinch his solution to the Copernican problem of how the earth moves. It is important to note, however, that, without the animistic strand to the argument, Gilbert could not satisfactorily explain the rotation of the earth. The magnetic nature of the earth will not suffice for Gilbert’s purposes.

67 Hesse, _op. cit._, 1-2.
68 Zilsel, _op. cit._, 3 and 5.
69 Harradon, 7.
It has long been recognized that Gilbert’s magnetic philosophy did not allow him to make any claims at all about the annual revolution of the earth around the sun. Johnson and Freudenthal see this as the reason for Gilbert’s pronouncement that he passes by “the earth’s other movements,” even though he was in fact a fully committed Copernican. The implication of Johnson’s and Freudenthal’s account, however, is that Gilbert’s magnetic philosophy allowed him to establish the diurnal rotation of the earth. But this is not strictly true; even his account of the diurnal motion is problematic. After all, magnets do not continually rotate on their polar axes. As Gilbert points out,

The whole earth regards Cynosura by its steadfast nature; and similarly each true part of the earth seeks a like place in the world, and turns with circular motion to that position. The natural movements of the whole and of the parts are alike: hence, since the parts move in a circle, the whole, too, hath the power of circular motion.

So, the earth has the power, like a magnet, to turn along part of a circle to face in a particular direction. But this is not the same as saying it can completely rotate once every twenty-four hours.

Gilbert lays claim to having established the diurnal rotation in what can only be described as a roundabout way. Having previously rejected the suggestion that the fixed stars continually rotate around the earth once every twenty-four hours, Gilbert declares that “Bodies that by nature move with a motion circular” must have in their parts “various metes and bounds,” namely “poles that are not merely mathematical expressions, an equator that is not a mere fiction, meridians, too, and parallels.” The earth fulfills this requirement, as Gilbert has shown, and therefore we know “that the earth rotates on its own poles, proved by many magnetical demonstrations to exist”—notice that it is the existence of the real (not mathematical) poles which has been demonstrated by magnetism, not the rotation. To justify the claim that the earth must rotate about these poles Gilbert effectively invokes the nature-does-nothing-in-vain gambit: why else would God have created real physical poles in the globe of the earth, if not to provide a fixed axis about which it could rotate?

For not in virtue only of its stability and its fixed permanent position does the earth possess poles and verticity; it might have had another

70 De magnete, Bk. VI, ch. 3, 327. Freudenthal, op. cit., 33; also, Johnson, op. cit., 216. Others have preferred to deny that Gilbert was a fully-fledged Copernican (Freudenthal, op. cit., 33, note 44, and Roller, op. cit., 162 and 173).
71 De magnete, Bk. VI, ch. 4, 331.
72 De magnete, Bk. VI, ch. 4, 328.
direction, as eastward or westward, or toward any other quarter. By the
wonderful wisdom of the Creator, therefore, forces were implanted in
the earth, forces primarily animate, to the end the globe might, with
steadfastness, take direction, and that the poles might be opposite, so
that on them, as at the extremities of an axis, the movement of diurnal
rotation might be performed.⁷³

In the end, then, the daily rotation of the earth was explained not by an
experimentally established earthly magnetism but by the animate nature of the
earth. It was that animate nature which was established by magnetic experi-
ments.

⁷³ *De magnete*, Bk. VI, ch. 4, 328-29.
ATOMISM AND ESCHATOLOGY:
Catholicism and Natural Philosophy in the Interregnum

Introduction
In spite of vigorous opposition by a number of historians it has now become a commonplace that the rapid development of the ‘new philosophy’ sprang from the ideology of Puritanism. What began its career as the ‘Merton thesis’ has now been refined, developed, and so often repeated that it seems to be almost unassailable. However, the two foremost historians in the entrenchment of this new orthodoxy are willing, in principle, to concede that ‘in reality things were very mixed up’, and that non-Puritan natural philosophers at the time were operating ‘in a precisely similar manner’ to their Puritan contemporaries. Indeed, it would be impossible not to concede this in the face of the many critiques launched against the Merton thesis.

Unfortunately, because of its undoubted successes in helping the historian to make sense of the period, there is now a very real danger that natural philosophers who cannot be assimilated into this picture will be ignored as irrelevant to the broader issues (whatever they may be taken to be). For example, although he has not said so in print, it would seem that Charles Webster has dismissed the relevance of the Catholic natural philosophers working with Richard Towneley in Lancashire during this period. In his brief but pioneering work on the predominantly Catholic Towneley group, Webster was able to raise his voice against the Merton thesis and to criticize Christopher Hill’s Intellectual origins of the English

An earlier version of this paper was read at the Open University in December 1980 and I would like to thank those present for their helpful comments. In particular my thanks are due to Drs David Goodman and Colin Russell. The paper has also benefited from my discussions with a number of others whom I should now like to thank. These are: Drs David Grylls, Michael Hunter, H. W. Jones, B. C. Southgate, Simon Schäffer, and Mr Stephen Pumfrey.


3 The major instruments of this entrenchment are Christopher Hill, The intellectual origins of the English revolution, Oxford, 1965; and Charles Webster, The Great Instauration, science, medicine and reform, 1626-1660, London, 1975.


5 C. Webster, op. cit. (3), p. 504.
revolutions} for taking too simplistic a view of things.\(^6\) By the time he came to write *The Great Instauration*, however, the importance of this group was all but forgotten and Webster denied them any serious part in his considerations. Webster was now assuming that the Towneley group, along with other ‘dissidents’ merely turned to natural philosophy because ‘for those excluded from civil office or political participation, the sciences were an unexceptionable form of recreation’.\(^7\) The Puritan movement towards science, however, was much more interesting and important, Webster argues, because ‘it can be shown that their scientific beliefs were framed with conscious reference to their religious views, each section within the Puritan sphere of influence developing a scientific outlook consistent with its doctrinal position’.\(^8\)

In this paper I wish to take up the challenge implicit in the work of Hill and Webster and show that there was indeed a small group of thinkers who operated in a similar manner to the Puritans and of whom we could say (as Webster has of the Puritans) that they provide ‘an invaluable case study’ by virtue of ‘their pronounced attention to scientific matters and the explicit manner in which they articulated their ideas about religion, society and the natural world’.\(^9\)

The Blackloists were a small group of English Roman Catholic thinkers who made a bold effort to establish a new counter-reforming Catholic theology in England. They took their name from the alias, Blacklo, of their leader, Thomas White (1593–1676), a secular priest. In spite of the small size of the group and the ultimate (inevitable?) failure of all their efforts, they deserve far more attention than historians have granted them so far.\(^10\) This is especially true in the field of history of science


\(^7\) C. Webster, op. cit. (3), p. 485.

\(^8\) Ibid., p. 503–4.

\(^9\) Ibid., p. 504.


The other known members of the Blackloists are, with one exception, even more obscure: Henry Holden (1596–1662), Peter Fitton (1602–1657), E. Tyrrel (1621–76), and H. Ellis (d. 1676). There is some information about these thinkers in Anstruther’s dictionary cited above. The only other member of the group to make a name for himself is also little studied: John Sergeant (1621–1707). John Sergeant was an ardent controversialist who came to the fore after the Restoration. I hope to examine the later fortunes of the Blackloists and the ideas of Sergeant in a forthcoming paper. Meanwhile, the best treatment of his thought can be found in G. H. Tavard, *The seventeenth-century tradition: a study in recusant thought*, Leiden, 1978, 219–45 (see also pp. 180–96 for a discussion of Henry Holden).
since the two main protagonists of this group, Sir Kenelm Digby and Thomas White, were extremely important in the early development of the mechanical philosophy in England. It is the intention of this paper to give a brief account of the religious and ideological concerns of Digby and White and to show how their scientific ideas were developed in order to promote their counter-reforming scheme. In so doing the paper will not simply provide another critique of Webster and Hill but will enrich and expand the prevailing historiography beyond the bounds of the ‘Puritanism-and-science’ thesis.

**Digby, White and the mechanical philosophy**

Sir Kenelm Digby and his mentor, Thomas White, are important in the history of science because they were the first Englishmen to produce a fully developed system of mechanical philosophy. Thomas White’s *De mundo* published in Paris in 1642, has still not received much attention but the recent discovery and publication of Thomas Hobbes’ long and detailed examination and refutation of the work goes some way to indicating its contemporary significance. It is immediately clear that the *De mundo* was greatly influenced by the work of Galileo and, in its turn, profoundly influenced Digby’s major contribution to natural philosophy. Sir Kenelm Digby’s *Two treatises*, which appeared in 1644, shares with Descartes’ *Principles of philosophy* the honour of being the first fully considered attempt at a mechanistic system. The fact that it was written in English can only have enhanced its importance among contemporary English thinkers.

Fairly detailed expositions of Digby’s *Treatise on body*, the first part of the *Two treatises*, have been provided elsewhere so we need not cover the same ground here. Suffice it to say that, while working almost entirely within an Aristotelian framework, Digby develops a heuristic system which has justly been described as ‘impeccable’ according to the precepts of the mechanical philosophy. In essence, Digby develops what can only

be described as 'Aristotelian atomism'. This may seem a peculiar hybrid but Digby himself tried to pass it off as a thoroughbred:

Let any man read his [Aristotle's] books of Generation and Corruption, and say whether he doth not expressly teach, that mixture (which he delivereth to be the generation or making of a mixt body) is done per minima, that is in our language and in one word by atomes.17

According to Digby's exegesis Aristotle professed that the natural qualities which arose from the combination of elements were brought about

by the mingling of the least partes or atomes of the said Elements, which is in effect to say that all the nature of bodies their qualities and their operations, are compassed by the mingling of atomes: the showing and explicating of which hath been our labour in this whole Treatise.18

Unfortunately, the fact that Digby chose to develop his atomistic mechanical philosophy within the framework of Aristotelianism has tended to obscure his undoubted significance. Digby has often been regarded as a predominantly old-fashioned thinker, fighting a rear-guard action at a time when all the major natural philosophers were trying to undermine and overthrow Aristotle. Such an attitude involves a rather simplistic assessment of the so-called scientific revolution even in general terms,19 and with regard to the revival of atomism in the early modern period it is completely misconceived. Kenelm Digby’s Treatise on body must be seen as the culmination of the Aristotelian minima naturalia tradition. Some of Aristotle’s early commentators, notably Averroes, interpreted certain of his pronouncements to imply the existence of minima naturalia, which were held to be the smallest particles of a substance which could take part in physical or chemical operations. The importance of this tradition for the revival of atomistic philosophies in the sixteenth and seventeenth centuries should not be underestimated.20 Digby (and White) took this tradition as far as it was to go and invested it with renewed vigour. When seen from this perspective, the Treatise on body would seem to show that the new mechanical philosophy, in its early stages, owed as much to Aristotelianism as it did to Descartes.21

17 Digby, Treatises, p. 343. 18 Ibid.
21 It is worth remembering in this context that F. Brandt concluded that the biggest influence on Hobbes' early mechanism was Aristotle. See F. Brandt, Thomas Hobbes' mechanical conception of nature, Copenhagen and London, 1928, pp. 55-72.
Even so, there is more to Digby’s work than this. The *Treatise on body* is so different from the work of the other Aristotelians in the *minima* tradition as to be almost in a class of its own. Digby did not merely tack on bits of atomist doctrine in order to shore up the crumbling structure of Aristotelianism, rather he re-built the whole edifice using atomism or mechanism as his mortar. Furthermore, Digby and his philosophical partner Thomas White were well-respected members of Mersenne’s circle and so were in the vanguard of philosophical developments. They were deeply influenced by the work of Galileo and Descartes, and were fully acquainted with the developing ideas of Hobbes and Gassendi. All of these thinkers, as is well known, were vigorous in their rejection of Aristotle, and we must ask ourselves why Digby and White did not follow suit. The main reason for their continued adherence to Aristotle will emerge as we turn to consider the ambitious motives that lay behind their work.

The origins of the Blackloist religio-political programme

Although he was brought up as a Roman Catholic, Digby abandoned his mother church in 1630 and became an Anglican. It may be that he became disenchanted with the Catholic Church at this time because he recognized that ‘Rome fetters reason’, but for the most part his conversion seems to have been an understandable case of opportunism, in order to avoid the disadvantages of being Catholic at a time when Catholicism was anathema to most Englishmen. However, by 1635 he had returned to the church of his birth, and shortly after this (1638) he embarked upon his career as a philosophical writer. Undoubtedly Digby reached this turning point and was given new direction by the aid and influence of the now little-remembered Catholic priest, Thomas White. Very quickly after their first meeting White’s influence upon Digby became more and more profound. Digby seldom failed to recommend the philosophy of this priest who, thereby, was initiated into Mersenne’s circle and attracted the interest of Digby’s friends, Descartes and Hobbes. Digby repeatedly referred to White as his master, mentor, and teacher. He once wrote to White saying that his whole philosophy had been shaped by the priest, even going so far as to say

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23 There are a number of sources for Digby’s biography besides the useful *Biographia britannica* and *Dictionary of national biography* articles. These include E. W. Bligh, *Sir Kenelm Digby and his Venetia*, London, 1932; J. F. Fulton, *Sir Kenelm Digby: writer, bibliophile and protagonist of William Harvey*, New York, 1937; V. Gabrieli, *Sir Kenelm Digby: un inglese italiano nell’ eta della controriforma*, Rome, 1957; but still the fullest is R. T. Petersson, op. cit. (12). I will restrict my references on bibliographical details to this last work. On Digby’s conversion to Anglicanism and return to Catholicism see idem, p. 94.
I should not lie if I said that your redeeming me out of vulgar ignorance hath been in some regard a misfortune to me, as the cure of madness was to the poor wretch who then saw his misery.  

The congruence between the ideas of these two men can be seen from even a cursory comparison of their published works, and yet the full significance of this intellectual partnership has yet to be fully assessed.

Unfortunately it is not possible to give an exact date for their meeting, but the circumstances which brought them together are fairly evident. It is reasonable to assume that during the few years which Digby spent as an uneasy Anglican he would have been interested in ecumenical movements. During this period he was a close friend of Archbishop Laud whose 'high-flying' Anglicanism was often thought to be dangerously close to Catholicism. Quite quickly after Digby’s conversion to Anglicanism there was a softening in attitude towards Catholicism among many Englishmen, and there were even a number of converts to the Church of Rome. Perhaps the most surprising of these was the temporary conversion of William Chillingworth, a thinker more usually known for his vociferous opposition to Catholicism. It began to seem to the Papal authorities that some sort of reconciliation between Rome and Canterbury was possible and in 1634 Pope Urban VIII sent Gregorio Panzani over to England to negotiate along ecumenical lines.

In 1633 a former colleague of Thomas White at the English College in Douai, Christopher Davenport, published Deus, Natura, Gratia which argued that no fundamental dogmas separated Anglicans and Catholics. White indicated his own ecumenism by writing a commendatory preface to the work. During Panzani's visit, White played a large role in his attempts to reconcile rival factions among English Catholic clergy. By 1636 when Panzani left England, White had emerged as a powerful figure in the secular clergy and had even been nominated as a possible candidate

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24 Letter from Digby to White, 25 February 1650, reprinted in R. Pugh, Blacklo's cabal (full citation given in note 91 below, p. 93.
25 See J. M. Lewis, op. cit. (10) for the only attempt to assess this partnership so far.
27 William Chillingworth, An account of what moved the author to turn Papist, with his confusion of the arguments that persuaded him thereto, in Works, London, 1719. See also R. R. Orr, Reason and authority: the thought of William Chillingworth, London, 1967, especially chapter 1, pp. 1–22. The reasons for this temporary softening of attitude are no doubt complex and, as far as I am aware, have not received sufficient analysis from historians. No doubt the rise of Arminianism played some role; see Tyacke, op. cit. (26) and J. B. Dockery, Christopher Davenport, friar and diplomat, London, 1960, pp. 47–61.
29 Franciscus, a Sancta Clara [Christopher Davenport], Deus, Natura, Gratia, sive tractatus de praedestinatione, de meritis & peccatorum remissione, seu de iustificatione & denique de sanctiorum in vocatione, Ubi ad trutinam fidei catholicae examinatur confessio Anglicana etc., Lyon, 1634. For a complete study of Christopher Davenport see J. B. Dockery, op. cit. (27). Chapters 4 and 5 deal with Deus, Natura, Gratia, pp. 62–93, and see also Appendix D, pp. 146–49. For a brief contemporary account of Davenport’s work see Richard Baxter, A key for catholicks to open the juggling of the Jesuists . . . a new edition revised by J. Allport, London, 1839, pp. 307–16.
for the Bishopric of Chalcedon—the Catholic Bishopric so-called in order not to 'prejudice any right his majesty hath to the nomination of English bishops'.

It seems quite likely that Digby became acquainted with White during these hopeful times for Catholics, and that White was one of the Catholic friends who, we are told by Laud, guided Digby back to his mother church in 1635. Certainly, by 1637 both men were well acquainted.

The ecumenical intentions of the Blackloists had their beginnings during these times, but the hoped for reconciliation between Rome and England did not materialize. Digby and White, however, despaired of nothing. From this time onwards they dedicated all their efforts to gaining toleration for English Catholics. Thomas White's most recent biographer has argued forcefully that, as far as White was concerned, all his writings, in whatever field of human knowledge, were part of a unified whole: a comprehensive system of religion, politics and philosophy. When one of White's most trenchant critics objected that it was not possible to know where his philosophy ended and where his theology began, White merely replied: 'I see not how you could give a schollar a greater praise'.

On another occasion White declared that all his endeavours were directed towards showing the conformity of faith with 'inferior sciences'. It is my contention that the one guiding principle which directed all of White's unified efforts was his belief in the importance of ecumenism.

White and his faithful follower and accomplice, Digby (along with other followers), tried to accomplish this (as we shall see) by direct political means: negotiating with members of the English Government or with Papal authorities in Rome. But what is more significant from our point of view is that they aspired to gain toleration for Catholics by making a deliberate effort to develop a reformed Catholic theology which was close to, or amenable to, English Protestant thought. Their writings, therefore, were all carefully composed with a view to removing those doctrinal differences between Catholics and English Protestants which stood in the way of reconciliation. In order to see this we must briefly examine the way their works developed from the late thirties to the early sixties.

In their earliest published works Digby and White tried to defend the

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32 In that year, or perhaps earlier, White and Chillingworth debated Catholic infallibility in Digby's lodgings. See George Digby, Letters between the Lord George Digby and Sir Kenelm Digby kt. concerning religion, London, 1631, p. 85. Thomas Birch in his 'Life' of Chillingworth dates this meeting in 1635, Chillingworth, Works, London, 1820, pp. 4–7, but Lewis, op. cit. (10) argues that it must have been between July 1637 and January 1638, p. 60.
34 Thomas White, Religion and reason, mutually corresponding and assisting each other, Paris, 1660, p. 25.
35 Thomas White, A letter to a person of honour . . . in vindication of himself and his doctrine, 1659 unpaginated [p. 18].
Catholic emphasis on tradition as an authority equal to the scriptures. For Catholics, the oral traditions of the early Church seemed to be every bit as reliable as the written testaments because they, so Digby and White claimed, could all be traced back to the direct teachings of Christ. While study of the scriptures alone could lead a man to the truths of religion, more often than not the difficulties of interpretation will lead to error and controversy. The proliferation of different sects within Protestantism testify to this. It is necessary, therefore, to be guided by the use of reason and by the traditional interpretations given to those controversial parts of scripture by the early members of the church. These early fathers, of course, had every advantage over the moderns in being able to determine Christ’s original meanings. Those to whom Jesus preached, they argued, ought to be believed as firmly as Jesus himself. The Roman Catholic Church was held to be unique in having an unbroken line of masters and disciples which could be traced back to Christ and his original chosen disciples. This was sufficient to guarantee that no false doctrines or errors could have crept in: only what Christ himself taught has been handed down. As White put it: ‘If we look into the immediate progresse and joints of the descent we cannot find where it can misse.’ Digby concluded that it was safe to allow oneself to be

guided by the unanimous consent of the wisest, the learnedest, and the piousest Men of the whole world, that have bene instructed in what they believe by men of the like quality living in the age before them, and soo from age to age until the Apostles and Christ,—and that in this manner have derived from that fountayne, both a perfect and a full knowledge of all.

Now, White first developed these ideas in the context of a polemic with the Anglican apologist, Lucius Cary, Viscount Falkland (1610–43). However, White’s _An answer to the Lord Faulkland’s discourse of infallibility_ was not the last word on the matter. Falkland himself was quick to reply and his close associate, William Chillingworth (1602–44) also entered the lists by composing a refutation of White’s ideas which was published posthumously. We also know that Chillingworth and White debated this topic face to face in Digby’s lodgings sometime between 1635 and 1637. The arguments of Falkland and Chillingworth were

36 Thomas White, _An answer to the Lord Faulkland’s discourse of infallibility_, reprinted in Lucius Cary, Viscount Falkland, _A discourse of infallibility, with Mr. White’s answer to it, and a reply to him_, second edition, London, 1660, p. 4. White’s answer was first published in 1651 but must have been written prior to 1637, see Lewis, op. cit. (10), 59.


39 See note 32 above.
Atomism and Eschatology

essentially the same. They sought to show that the doctrinal development of the Roman Church was by no means as smooth and indefectable as White and Digby wanted their readers to believe. They were able to find a number of doctrines which separated Protestant and Catholic and which they could show had equally divided Catholic from Catholic in the past. The major doctrinal issues were the immaculate conception of the Blessed Virgin, infants receiving the Eucharist, transubstantiation, Papal infallibility and eschatological beliefs. From this moment on the theology of Digby and White underwent an astonishing transformation. They recognised that the arguments of Falkland and Chillingworth were sufficient to undermine completely their own arguments about the infallibility of tradition and the historical coherence of orthodox Catholic theology. From then on White and his followers became convinced of a genuine need to reform the Catholic Church from within. White and the Blackloists now began to reject certain Catholic dogmas in the hope of making their own reformed Catholicism not only more amenable to English Protestants, but also more comfortable to the true faith.

When White wrote his own mechanical system of philosophy, an expansion of Digby's Two treatises, he showed no hesitation in denying that an accident could exist out of its own subject. As White himself pointed out he thereby denied Catholic teaching upon transubstantiation; nevertheless he was adamant:

'Tis answered there's neither Authority nor Demonstration in Theologie, which convinces that an Accident may be preserv'd out of a Subject...

Similarly, he indicated that he held no brief for Catholic Mariology. However, by far the most important aspect of the new theology of White and Digby was their rejection of the concept of purgatory and their development of a new Catholic eschatology.

Much recent research has shown the prevalence and importance of apocalyptic beliefs and related eschatological concepts in seventeenth-century England.

40 Lucius Cary, Reply, p. 65, 82, 187. Another important aspect of the debate between Falkland and Chillingworth on the one hand, and White and Digby on the other, arose from the rational scepticism of the two Protestants, as opposed to the firm belief in the possibility of absolute knowledge professed by the two Catholics. I do not intend to deal with this here but see Southgate, op. cit. (10), chapters 5, 6, 9 and passim. For the background to the scepticism of Falkland and Chillingworth see H. R. McAdoo, The spirit of Anglicanism: a survey of Anglican theological method in the seventeenth century, London, 1965, chapter 1, pp. 1-23; R. H. Popkin, The history of scepticism from Erasmus to Descartes, revised edition, New York, 1968; and H. G. van Leeuwen, The problem of certainty in English thought, 1630-1690, The Hague, 1963.

41 Thomas White, Peripatetical institutions: in the way of Sr. Kenelm Digby: the theoreticall part, London, 1656, p. 196. This work first appeared in Latin: Institutionum peripateticarum, Lyon, 1646. As the title indicates, White draws heavily upon Digby's Treatise but he expands the scope of his own work to include cosmological, meteorological and geographical phenomena.


43 Interest in this topic seems to have been inspired by the pioneering work of Norman Cohn in 1957, now re-issued as Norman Cohn, The pursuit of the millennium: revolutionary millenarians and mystical anarchists of the middle ages, revised and expanded edition, London, 1970. Works which concentrate on
in all of this research, is highly significant in this respect and adds greatly to our understanding of this historical development. In view of the apocalyptic excitement which we now know was stirred up in those times, it is hardly surprising that White and Digby recognized its importance in English religious thought. Furthermore, Digby’s friend Thomas Hobbes, as is well known, was developing his own eschatology which emphasized the resurrection of the body and the Last Judgement. And then, in those works of Falkland and Chillingworth directed against White, millenarianism appeared as one of the major examples of a piece of early Catholic tradition now rejected as heresy.

Chillingworth rightly insisted that the ‘doctrine of the millenaries’ was ‘by the present Roman Church held false and heretical’. However, bearing White’s criteria in mind it ought to be part of the true faith because it was ‘believed and taught by the Eminent Fathers of the Age next after the Apostles, and by none of that age opposed or condemned’. Irenaeus, for example, was said to have derived it ‘from Priests which saw John, the Disciple of the Lord’. Similarly, Justin Martyr is quoted as saying that those who denied the millennium also denied the Resurrection. Furthermore, the doctrine of millenarianism is to be found in the Revelations to St John and was an accepted part of Christian belief within thirty years of his death, ‘when in all probability there were many alive, that had heard him expound his own words and teach this doctrine’. It remained part of the orthodoxy, according to Chillingworth, for two hundred and fifty years until contradicted by Dionysius Alexandrinus.

Although Falkland and Chillingworth invoke millenarians in this way it should not be assumed that they were thoroughgoing millenarians themselves. The evidence tends to suggest that they were simply using these arguments to demonstrate the untenability of the Catholic claim to a theology based on the earliest traditions of the Church. In fact the recent proliferation of studies on millenarianism has rather tended to obscure the


45 Chillingworth, Discourse concerning tradition (full citation in note 38), p. 33.

46 Ibid., 33, 34. 47 Ibid., 34.

48 Ibid., 36. 49 Ibid., 37.
fact that it was regarded by most English thinkers as an unorthodox view, which could lead to heresy in religion and political upheaval in everyday life. This is not to say that orthodox Anglicans denied the general resurrection and the Last Judgement, but for the most part they concentrated more on the very clear scriptural statements that the blessed would enter heaven and the damned would be punished immediately after death. This emphasis straight away raises questions about the importance of the Last Judgement—most obviously: why should it be necessary at all? Anglicans for the most part followed Calvin’s teaching in the Institutes of the Christian religion:

... as the Scripture uniformly commands us to look forward with eager expectation to the coming of Christ, and defers the crown of glory which awaits us till that period, let us be content within these limits which God prescribes to us—that the souls of pious men, after finishing their laborious warfare, depart into a state of blessed rest, where they wait with joy and pleasure for the fruition of the promised glory; and so, that all things remain in suspense till Christ appears as the Redeemer. And there is no doubt that the condition of the reprobate is the same as Jude assigns to the devils, who are confined and bound in chains till they are brought forth to the punishment to which they are doomed.  

The Last Judgement, therefore, is still anticipated but, in the mean time, the departed souls are kept at some sort of half-way stage. It is essential to think in such terms in order to account for Jesus’s promise to the blessed thief: ‘Today shalt thou be with me in paradise’, and for the fact that Dives, after his death, could see Lazarus comforted in ‘Abraham’s bosom’. Jeremy Taylor, writing in 1649, explained the quandary by relying on a distinction made by St Paul between paradise and the highest heaven:

for paradise is distinguished from the heaven of the Blessed, being itself a receptacle of holy souls, made illustrious with visitation of Angels and happy by being a repository for such spirits, who at the first day of Judgement shall go forth into eternall glory.  

50 See, for example, Jeremy Taylor, The liberty of prophesying, London, 1648, pp. 84–5, where he denies the authority of Papias and other early chiliasts. The unorthodoxy of these ideas may also explain why Chillingworth’s refutation of White remained unpublished during his lifetime. See also below, pp 234–36.

51 Jean Calvin, Institutes of the Christian religion, translated by John Allen, 3 vols., London, 1813. Book III, chapter 25, section 6, p. 478. It is not necessary to distinguish here between the Calvinist and Arminian or Laudian Anglicans who have been delineated by Nicholas Tyacke, op. cit. (26). Tyacke points out that Anglicanism in the early part of the seventeenth century was doctrinally Calvinist, 119–29 (see also McAdoo, op. cit. (40), pp. 21, 24–30), but this was superseded by Arminianism with the rise of the Laudian faction, after Charles I came to the throne. The Arminian rejection of Calvinist doctrine was centred on predestination, however, and it seems that Laudian Anglicans did not differ from Calvin on the issues of eschatology. This is certainly the case with Jeremy Taylor, cited below, and is also true of Henry Hammond, one of the leading Laudians. H. Hammond, The Works, 4 volumes edited by W. Fulman, London, 1684, i, 703; iii, 363, 855–61. On Hammond see J. W. Packer, The transformation of Anglicanism, 1643–1660, with special reference to Henry Hammond, Manchester, 1969.

52 Luke, 23, 43.  

From this point of view, however, it seems that the Last Judgement has been reduced to a mere formality: those in Abraham’s bosom know their blessedness will be ratified, while those ‘bound in chains’ must know there will be no reprieve. The only way that orthodox theologians could make the Last Judgement relevant was to argue that complete justice could not be meted out to the whole person, body and soul, without the resurrection of the body. In life the bodies of the innocents suffered as much as their souls and bodies too deserved their rewards, and conversely it was often bodily pleasures which led the wicked astray and so it is fitting that their bodies should be punished.

In spite of these efforts it should still be recognized that, in general, the Day of Judgement was played down by representatives of orthodoxy and more emphasis was given to the immediacy of punishment or reward after death. This was partly in order to avoid encouraging the political and social upheavals that seemed inherent in the millenarian views, but orthodox thinkers were also determined to reject the heresy of mortalism which was becoming, from their point of view, alarmingly prevalent. Mortalism, the belief that the soul dies with the body or, in a less extreme version, remains sleeping in total oblivion until the resurrection (when it is resuscitated along with the body), was feared to have social implications as bad as those of millenarianism. If the soul died with the body then the normal religious constraints towards good morals counted for nothing, and immorality of the worst kinds would ensue. Implicit in these fears is the assumption that reward or punishment deferred indefinitely to the time of the Last Judgement would simply be ignored by most people.

Be that as it may, the more radical Protestant thinkers were not satisfied with the comparatively unimportant Last Judgement of orthodoxy. For them, the bodily resurrection and the Last Judgement were the major aspects of their belief; the culmination of the history of the world. The state of souls between death and the eventual Judgement Day, therefore, required more careful consideration than it was granted by conservative theologians. It was clearly for this very reason that mortalism became so prevalent.

It is only in the light of all this that we can see the ideological purpose behind the philosophical works of Digby and White. In order to reunite all Christians: Puritan, Anglican and Catholic, in a reformed Ecumenical Church, Digby and White would have to rediscover the true faith.

55 The possibility of a reprieve would have to be ruled out to avoid similarities with the Catholic concept of purgatory.
56 Jeremy Taylor, Great example, p. 171. This notion was regarded as heretical, however, in Thomas Edwards, The third part of Gangraena, or a new and higher discovery of the errors, heresies, blasphemies, and insolent proceedings of the sectaries of these times . . ., London, 1646, p. 8.
58 Charles Webster refers to the tradition of 'providential history', op. cit. (3), 1–6.
Furthermore, they had to be able to demonstrate that it really was the one true faith in order to persuade all Christians to join them. In general terms they sought to do this by developing a unified philosophical theology based on what they took to be the three major sources for incontrovertible knowledge: scripture, tradition and reason. Throughout their work Digby and White return again and again to these three sources as the only infallible guides to the doctrines of the true faith, and it is this which accounts for the striking coherence of all White’s works which has already been noted. More specifically, what the Blackloists required was a reformed theology which would include the early traditional belief in the general resurrection and the Last Judgement, but would also avoid the mortalist heresy and prove the immortality of the human soul.

The mechanical philosophy in the service of eschatology

The first major step towards this counter-reforming theology was made in Digby’s *Two treatises*. Although it is the *Treatise on body* which has attracted most attention from historians of science, for Digby the really important part of the work was its development of a comprehensive physiology of the human soul, in the second treatise. As he wrote in the ‘Dedicatory epistle’, he intended to study corporeal agents only in so far as ‘the knowledge of them serveth to the knowledge of the soul’. That the *Two treatises* were actually written with this religious purpose in mind is also clear from what Digby wrote in 1642 in his *Observations upon Religio medici*. In this short work Digby insists that the immortality of the soul can be demonstrated by philosophy ‘as well as faith delivereth it’:

I take the immortality of the Soule (under his [Browne’s] favour) to bee of that nature that to them onely that are not versed in the wayes of proving it by reason, it is article of faith; to others it is an evident conclusion of demonstrative Science.

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59 See above p. 217 and Southgate, op. cit. (10), p. 1 and passim. White continually emphasized the use of reason in order to get at the truths of scripture and tradition. This can be seen in the titles of two of his works: *Religion and reason mutually corresponding and assisting each other*, Paris, 1660; and *Description and reason*. First essay wherein modern devotion for the dead is brought to solid principles and made rational, Paris, 1661. White, like others in the seventeenth century (notably Hobbes and Descartes) believed that rigorous reasoning could be ensured by following the axiomatic method of Euclidean geometry. There are numerous examples of this method in the work of White. Perhaps the most interesting example for the historian of science is his *Appendicula tentans solutionem problematis Toricelliani de subsistentia hydrargyri in tubo superne sigillato*, London, 1663 (appended to *Scirri*, see note 114 below). But see also his *Euclides physicus, sive de principiis naturae, stoecheida etc.* , London 1657; and *Euclides metaphysicus, sive de principiis sapientiae, stoecheida etc*. , London, 1658. For a fuller discussion of this aspect of White’s work see H. W. Jones, ‘Leibniz’ cosmology and Thomas White’s *Euclides physicus’, *Archives internationales d’histoire des sciences*, 1975, 25, pp. 277–303. For a general survey of this important topic see H. Schüling, *Die Geschichte der axiomatischen Methode in 16 und beginnenden 17 Jahrhundert*, Hildesheim, 1969.

60 Digby, *Treatises*, sig. à iv.


He then gives advance notice that he has demonstrated the immortality of the soul by rational means in a long philosophical work. It would seem from this that the *Two treatises* were actually written sometime before the end of 1642. Digby also makes it abundantly clear that his philosophy can be used to refute mortalism:

> I shall observe how if hee had traced the nature of the soule from its first principles, hee could not have suspected it should sleepe in the grave till the Resurrection of the body.  

In order to trace the nature of the soul, however, Digby felt it 'an unavoidable necessity' to deal in an exhaustive way with the nature of bodies. Furthermore, he recognizes the need to explain all the properties of bodies in mechanical terms. The current doctrines of the schools make no real distinction between material and spiritual things whose operations are alike attributed to 'certain powers or qualities' and so, as Digby complains:

> What hope could I have, out of the actions of the soule to convince the nature of it to be incorporeall if I could give no other account of bodies operations, then that they were performed by qualitie occult, specificall or incomprehensible?

If, on the other hand, he could banish occult qualities and powers from the realms of physics he would be at liberty to explain spiritual phenomena in terms of occult qualities. An exhaustive account of the phenomena of bodies which relied only on the principles of the mechanical philosophy would enable Digby to show that the operations of the soul

> are such as cannot proceed from those principles, which being adequate and common to all bodies we may rest assured, that what cannot issue from them, cannot have a body for its source.

The essence of Digby's thesis is to show that the soul is incorporeal and to go on from there to demonstrate its immortality. Mortality, involving change, decay, dissolution and so forth, can only apply to material entities since all change can ultimately be explained in terms of the rearrangement in space of the constituent parts of bodies. A separated or 'unbodied' soul, therefore, must be completely incapable of change. The very last chapter of the *Two treatises* treats 'Of the perseverance of a soul in the state she findeth her selfe in, at her first separation from her

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64 Digby, *Treatises*, sig. ö vi.  
65 Ibid., sig. ü.
Here, Digby reaches the conclusion that 'no change at all can happen to an abstracted soul'. Once again, there are intimations of these ideas presented in his *Observations upon Religio medici*. For example, he tells us that 'in the state of eternity there is no succession, no change, no variety. Soules or Angells in that condition, doe not so much as change a thought'. He also takes Browne to task for implying a contradiction 'in his consideration of the activity of glorifieed eyes (which shall be in a state of rest; whereas motion is required to seeing)'.

Implicit in Digby's conclusion to the *Two treatises* is a denial of the Catholic concept of purgatory. If the soul is unchanging after death then it is ludicrous to suppose that souls can be purged of their sins before the resurrection on the Day of Judgement. Digby makes it rather more explicit in his shorter Observations:

> to be in such a condition as maketh us understand damned soules miserable; is a necessary effect of the temper it is in, when it goeth out of the Body, and must necessarily (out of its owne nature) remain in, invariably for all eternity.

It is quite evident that Digby's *Treatise on body*, the earliest fully worked-out system of mechanical philosophy in English was written to provide a philosophical basis on which to erect a new eschatology.

The details of this new eschatology were set out clearly and fully for the first time in Thomas White's *De medio animarum statu*, which was published in 1653. This work marks the culmination of White's attempts to arrive at a reformed Catholicism with no fundamental doctrinal differences from English Protestantism. With this new theology he believed he could bring together the more radical Protestant sects which emphasized the apocalyptic and eschatological features of Christianity and the more conservative Anglicans who tended to deny or play down the apocalyptic aspects. By paying sufficient attention to the 'middle state' of souls, he believed he could avoid the heresy of mortalism while also placing great emphasis on the importance of the resurrection and Last Judgement. As he himself insisted: 'whether we cast our eyes on the old or new Testament, we shall find our faith founded and rooted in the resurrection.'

From the outset of White's *Middle state of souls* it is clear that the

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66 Ibid., 443-45. 67 Ibid., 445. 68 Digby, *Observations*, p. 17. 69 Ibid., 41. 70 Unfortunately, Digby never explicitly considers how a soul can be purged when it is conjoined to the body. It is fairly clear, however, that he believes the soul to become capable of change in some way while established in the body.


72 Thomas White, *Villicationis suae de medio animarum statu ratio episcopo Chalcedonensi reddita a Thoma Anglo...*, Paris, 1653. This appeared in English as: *The middle state of souls from the hour of death to the day of Judgement*, 1659, and this edition has been used here. The ideas expressed in this work are reiterated throughout White's subsequent work. See especially: *The state of the future life, and the presents order to it*, London, 1654, and *Notes on Mr. F. D.'s result of a dialogue concerning the middle state of souls*, Paris, 1660.

73 White, *Middle state*, p. 37.
author has thoroughly absorbed the criticisms of Falkland and Chillingworth. However, this does not mean that he must rescind his views on the infallibility of tradition. On the contrary, he reaffirms it by following the paths indicated by the two Protestants. He categorically repudiates the concept of purgatory as something 'new in the Church' and so not part of true tradition. Furthermore, from the stand-point of his own natural philosophy he is able to argue that the very idea of purgation of sins after death and prior to a bodily resurrection is completely untenable.

Following Digby, he argues that only corporeal entities can suffer from external corporeal agents such as fire or instruments of torture. It is 'a fiction vain and altogether impossible', therefore, to suppose that a spiritual, 'indivisible subject' like the human soul could be affected by such external agents. But, if it is true that purgatory cannot purge the soul, it must also be true that the soul cannot suffer in hell-fire. It would seem that White's theology is leading him towards mortalism. White manages to avoid this by introducing a concept of internal gladness or, when appropriate, suffering. In other words he introduces a strictly psychological interpretation of Abraham's bosom, and the torments of the soul in the interval between death and the resurrection. So, just as 'the Embryo or seminal concreation delineats the future man', similarly the whole course of a man's life will determine the state of his soul at the moment of his death. As White himself puts it: 'to have had, in the course of his whole life, these and these thoughts and affections, designs and points out, by the impressions left, the future condition of his soul'. However, as soon as the soul becomes separated from the body it is no longer capable of or susceptible to change—since change is a physical phenomenon which it is nonsensical to apply to spiritual entities. Therefore, the disembodied soul must remain in the state it was in at the

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74 Ibid., p. 260. 75 Ibid., p. 97.
76 In fact, White and Digby have been accused of mortalism from time to time. Alexander Ross wrote against Digby and Richard Overton, a notorious mortalist, in the same work: The philosophical touchstone: or observations upon Sir Kenelm Digby's discourse of the nature of bodies and of the reasonable soul... and the weak fortifications of a late Amsterdam ingenier [Richard Overton] patronising the souls mortality briefly slighted, London, 1645. The fullest treatment of White's eschatology before Lewis, op. cit. (10), saw him as a mortalist: Francis Blackburne, An historical view of the controversy concerning an intermediate state and the separate existence of the soul between the death and the general resurrection, deduced from the beginning of the Protestant reformation to the present times. The second edition, corrected and greatly enlarged, London, 1772, p. 115. See also C. A. Patrides, Milton and the Christian tradition, Oxford, 1966, pp. 264-5.
77 White, Middle state, p. 153. Cf. note 71 above. White's psychological interpretation of the suffering endured by the soul after death is very similar to the view expressed by the ranter Jacob Bauthumley in The light and dark sides of God, London, 1650. See N. T. Burns, op. cit. (57), p. 84; and Cohn, op. cit. (43), pp. 305-6. Such ideas were fairly common among the radical protestant sects according to Christopher Hill, The world turned upside down: radical ideas during the English revolution, Harmondsworth, 1975, pp. 175, 177. This gives further confirmation of my argument that White's theology was capable of absorbing radical ideas and integrating them with more orthodox beliefs. It should be remarked, however, that these ideas were not totally revolutionary but can be traced back to Origen and other early Fathers. See D. P. Walker, The decline of hell: seventeenth-century discussions of eternal torment, London, 1964, 61-3.
78 White, Middle state, 103-4.
very moment of death: 'the Entity so made continueth such', White says, 'till it be, as it were, new moulded, which is the worke of the Resurrection'.

The soul neither dies nor sleeps, then, but remains fully self-conscious, indefinitely, in a state of self-inflicted guilty torments or tranquil joy, until the resurrection when it is once again conjoined to the body. The whole person, body and soul, can then suffer hell-fire, or be 'admitted locally to Heaven'. White sums it up like this:

Being therefore by the operation of death, as it were new moulded and minted into a purely spiritual substance, he carries inseparably with him the matter of his torment in the like manner as he also doth who takes leave of the body with his affections only venially disordered. We have no occasion here to employ infernal Architects to invent strange racks and dungeons, since the innate and intimately inhering strife and fury of the affections bent against reason, perform alone that execution; which is therefore proportional to the sins, because springing and resulting from them, nor ever otherwise possibly capable to cease and determine, unless the soul by a new conjunction with the body, became again susceptible of contrary impressions.

Clearly, White's carefully-thought-out natural philosophy, leading him to his new psychology of the disembodied soul, enabled him to develop a theology which he believed could resolve the exegetical problems of eschatology which divided English Protestants. Furthermore, if Catholics would accept, as he had, the arguments of Falkland, Chillingworth and other Protestants, that purgatory was not part of the true tradition of the Church, then White’s theology could be accepted by all as the true faith.

It should also be noticed that White’s new eschatology carried with it some important corollaries which could only have helped his ecumenical designs. Keith Thomas has pointed out that the belief in ghosts—souls revisiting their haunts from purgatory—was seen as a Catholic superstition which tended to be denied by Protestants. For this very reason, White was concerned to deny the reality of ghostly appearances. More importantly, White’s denial of purgatory undermined the validity of indulgences. The idea of buying one’s way out of purgatory, to which the concept of indulgences so often amounted, was anathema to Protestants. Besides, the abuses of indulgences were still remembered as one of the major incentives to the initial Lutheran Reformation.
The Blackloists and political developments

Thomas White and his fellow-traveller, Kenelm Digby, it should now be said, were not such ivory-tower intellectuals that they believed their new philosophical theology would be sufficient to achieve the ecumenical ends for which they yearned. Both men, and their devoted group of followers who were mostly, like White, secular priests, were actively engaged in various political machinations all bent upon the same objective. The full details of these political manoeuvres are extremely complex and have yet to be fully charted, but the broad outlines are perfectly clear. In 1639 Digby had been prevailed upon by Queen Henrietta Maria to ask English Catholics for funds which would enable King Charles to put down the Scottish rebellion. This marked the beginnings of a close relationship between Digby and the Queen. In 1644 when Henrietta Maria arrived in Paris she made Digby Lord Chancellor of the Court-in-exile, and commissioned him to go to Rome to entreat for Catholic funds. This errand was potentially crucial not only to the plight of the King, now embroiled in the first civil war, but also to the future of English Catholicism. It is not surprising, therefore, that Thomas White chose to accompany his close friend on this mission to Rome.

Needless to say, Digby failed in his endeavour. The Pope’s conditions were ludicrously impractical, including, for example, the conversion of Charles. A second and longer sojourn at Rome from 1646 to early in 1648 also produced no results. Digby was profoundly disappointed at his failure to help his King and Queen and there is good evidence to suggest that he was thoroughly disgusted with the Pope, Innocent X. It seems that White too, shared this low opinion of the Papacy and as a result decided to emphasize what previously had been only implicit in his intentions. The main problem confronting English Catholics, and preventing their toleration by English Protestants, was, at its simplest, the belief that no-one could be the servant of two masters: King and Pope. White and his followers, therefore, began to promote a schism between English Catholics and the Papacy. By this time the Blackloists constituted a powerful faction in the Chapter of secular clergy.

Many of the details of their schismatical plotting have been preserved in an account evocatively entitled Blacklo’s cabal. In September 1647 the
Blackloists drew up a list of 'Instructions' in which they detailed the concessions which Catholics should make in order to gain toleration of worship. These included taking an oath of loyalty to the English Government, denying fealty to the Pope, the establishment of six or eight Bishops who were completely autonomous and concerned exclusively with spiritual matters, and finally, the Blackloists recommended the expulsion of the Jesuits, who were seen as the biggest obstacle to ecumenism.\footnote{Ibid., 33–34 and 36–40. For an account of the Blackloist opposition to the Jesuits see R. I. Bradley, 'Blacklo and the counter-Reformation: an inquiry into the strange death of Catholic England', in G. H. Carter (ed.), \textit{From the renaissance to the counter-reformation: essays in honour of Garret Mattingly}, London, 1966, 348–70. It is evident from Gregorio Panzani, \textit{op. cit.} (28), that the Jesuits were the major stumbling block to any ecumenical movements. For surprising indications as to just how far the Blackloists were willing to go in their opposition to the Jesuits see M. V. Hay, \textit{The Jesuits and the Popish plot}, London, 1934.}

By this time, of course, the King’s cause was in ruins and the Government which had to be persuaded to grant freedom of worship was that of the rebels. It is an indication of the single-mindedness of the Blackloists that in 1649 shortly after the execution of the King, Digby returned briefly to England and once again negotiated for toleration for his fellow communicants. This time, he was dealing, in secret, with Oliver Cromwell, but like his other efforts it came to nothing. As well as a denial of the temporal power of the Pope, Cromwell wanted English Catholics to provide an army of ten thousand men for the service of the Commonwealth. Neither Digby nor any other Catholic could guarantee that.\footnote{Ibid., 251. See also the articles on Digby in \textit{Biographia britannica}, and \textit{DNB}. Digby’s close association with Cromwell is perhaps not so surprising as it may seem at a superficial glance. Cromwell seems to have been more inclined to grant freedom of worship than most of his contemporaries. See R. S. Paul, \textit{The Lord Protector: religion and politics in the life of Oliver Cromwell}, London, 1955, 327–8 and 331–3; and Dockery, op. cit. (27), 124–6.}

Even so, Digby did not despair and, as is well known, when Cromwell became Lord Protector in 1653, he returned to England and recommenced his efforts. And so, surprising though it may seem, this man who was once so ardent in his support of the King, now became something of a favourite in the eyes of the Lord Protector.\footnote{John Webster, \textit{Academiarum examen, or the examination of academies}, London, 1653, p. 53. This is now conveniently reprinted in A. G. Debus (ed.) \textit{Science and education in the seventeenth century: the Webster-Ward debate}, London, 1970.}

Meanwhile, the philosophical work of Digby and White was beginning to win the approval of leading Protestant thinkers. When John Webster recommended the reform of the university curriculum in his \textit{Academiarum examen} of 1653 he took for granted the importance of Digby and White:

\begin{quote}
What shall I say of the Atomical learning revived by that noble and indefatigable person Renatus des Cartes, and since illustrated and improved by Magnenus Regius, White, Digby, Phocyllides, Holwarda and divers others.\footnote{John Webster, \textit{Academiarum examen, or the examination of academies}, London, 1653, p. 53. This is now conveniently reprinted in A. G. Debus (ed.) \textit{Science and education in the seventeenth century: the Webster-Ward debate}, London, 1970.}
\end{quote}

regulars, unjust against the laity, scismatical against the Pope, cruel against orthodox clergyman, and owning the nullity of the chapter, their opposition to the episcopal authority, Douay?, 1680.
It would be wrong to assume that Webster was so radical as to be unrepresentative. It has been pointed out that the works of Digby and White frequently appeared alongside those of Descartes, Gassendi and Mersenne on the shelves of Oxford College libraries just after the civil wars.\(^96\) And Thomas Barlow of Queen's College included their works in his recommendations for *A library for younger schollers*.\(^97\) When Webster's book was answered by the more conservative Seth Ward and John Wilkins, the mechanical philosophy of our two Catholics was spared from the vilification heaped upon that of Thomas Hobbes.\(^98\) Indeed, Ward accused Hobbes of plagiarising from 'Des Cartes, Gassendi, S. K. Digby, and others.'\(^99\) Two years later Ward, once again, praised 'illustrious' Digby and White in the same breath as Gassendi, and described the two Englishmen as *praeclarissimi*\.\(^100\) John Wallis, the Oxford mathematician dedicated his *Commercium epistlicum* to Digby and included in it a letter fulsome in its praise of Digby and declaring that he, Wilkins and Ward were all 'deeply indebted to M. White'.\(^101\) Ralph Bathurst, Fellow of Trinity, has also been recorded giving high praise to Digby and White.\(^102\)

Gratifying though these praises must have been, it is clear that they did little to serve the Blackloists' great purpose. Evidently something more had to be done and in 1655 White made his boldest attempt to ingratiate the Blackloist cause to Oliver Cromwell. In that year he published a political treatise entitled *The grounds of obedience and government*.\(^103\) This work purported to give a strictly rationalist account of the circumstances under which a government should be obeyed and when it should not. White argued that although people prefer to make their own choices about how to act, lack of time and expertise, and the complexities caused by living in large communities made it expedient to entrust certain decisions to others. This delegation of responsibility is voluntary and derives from self-
interest. Men are best governed when they are themselves convinced of the
necessity of the course of action outlined for them. So the governors should
aim at what is best for the people. Under these conditions obedience is
justified and desirable, but the governors must not exceed or abuse their
power. White defines government, then, as 'a power or right of directing
the common affairs of a multitude, by a voluntary submission of the
communities wills to the will of the Governours'. If, however, the
governors should cease to serve the best interests of the people then a
revolution to depose that government and replace it with another is
justified. Furthermore, White even declares that it is reasonable to kill the
dispossessed governor if he is threatening a revenge which is not
consonant to the public good. For, 'when ever ... the common good is
clearly on the possessor's side then the dispossessed hath no claim'.
Inspired largely by the rationalist politics of Hobbes, the motivation
behind this work is perfectly obvious.

Clearly, White was engaged in a blatant attempt to demonstrate to
the Lord Protector that Blackloist Catholicism could be counted upon to
back him if he granted toleration to this new reformed Church. It hardly
needs saying that it all came to nothing. The mistrust of Catholics was
evidently so deep-seated that no matter how far White travelled away
from the doctrinal norms of the church of his priesthood, he still could not
win toleration. What is more, making his political intentions as obvious as
he did in The grounds of obedience, he had very definitely put all his eggs in
one basket. When, in 1660, King Charles II ascended his father's throne,
White's political views were, to say the least, extremely embarrassing. He
had expressed himself so clearly and so forcefully that it would have
availed him nothing to rescind his views on government. Digby, in spite of
all, was still Chancellor and friend to Henrietta Maria but even he was
compromised now by his association with White, and never really gained
the new King's favours. The Blackloists, as a movement, continued
their campaigning but White himself retreated increasingly into the
background.

Conclusions and implications

We can now begin to draw some conclusions from all of this. The
development and coherence of the philosophical and theological thought
of Digby and White indicates that the motive force behind all their work,
even their mechanist natural philosophy, was to re-establish the one true

104 White, Grounds, 9.
105 Ibid., 47.
106 Ibid., 147.
107 Ibid., 152.
109 White continued to write and publish after the Restoration but he did not play an active role in
the Chapter after that date, possibly because of the increasing condemnation of his work by the Holy
Office (his works were censured in 1655, 1657, 1661, and 1663), and no longer seems to have involved
himself directly in any of the political endeavours of the Chapter. Lewis, op. cit. (10), 230; Southgate,
op. cit. (10), 10; and Anstruther, op. cit. (10), ii, 351.
faith which would be capable of re-uniting all believers. The fact that their natural philosophy was intended to provide a foundation for the establishment of their new theology did not go unrecognised by their contemporaries. One of their most eloquent critics drew up an analysis of the development of their work:

Now as the order in which this new fabric of Purgatory, and indeed the whole new system of philosophy and Divinity was made publick; it was (as I take it) this: after the Book of the immortality of the soul, fathered on Sir Kenelme Digby; Master White appeared himself on the stage, under the name of Thomas the Englishman ... where, in a moderate volume entitled Peripatetic Institutions ... He discovered the great mine of this philosophy; here the suttleties of Logick, the secrets of nature, the hidden properties of bodies, both heaven and earth are layed open ... 

Similarly, another observer declared that Digby was easily wrought upon to help to bolster up and spread the Atomical philosophy, which Blacklo persuaded him would shortly prevail in the Christian world ... which Honour they said he should have of founding this new doctrine, & divinity it self, which was to be new modeled also according to these unheard of principles ...

It may be that the modern reader will simply suppose that White and Digby were out and out opportunists, willing to sacrifice any Catholic doctrine in order to gain toleration for their fellow communicants. If this were so, however, we would have to ask ourselves why they should have bothered to retain the name of Catholic. If they were willing to sacrifice so much of the doctrine, why not sacrifice the name also? In fact, the only way to do justice to the Blackloist programme is to see it as a major development within a particular tradition of counter-Reformation theology. There were many Catholic thinkers who believed that the counter-Reformation should not be simply a negative reaction to the Protestant Reformation, seeking merely to restore the pre-Lutheran supremacy of the Roman Church. Such men envisaged the counter-Reformation as a new reformation of the Apostolic Church from within. A successful reform would rediscover and re-establish the true faith, which, by definition, would be unique and would once again be accepted by all Christians. If we see the Blackloists in this light it is possible to make sense of their activities. They saw no contradiction in arguing for the truth of certain typically Protestant beliefs while still insisting upon the general supremacy of Roman Catholicism. After all, the Blackloists could only be sure they had recovered the true faith of primitive Christianity because it

10 S. W. A vindication of the doctrine contained in Pope Benedict XII, his bull and in the general council of Florence under Eugenius III concerning the state of departed souls ... Wherein the progress of Master White's lately minted purgatory is laid open and its grounds examined etc., Paris, 1659, 8.

11 R. Pugh, Blacklo's cabal, from 'The epistle to the Catholic reader', unpaginated [p. 6].

12 R. I. Bradley, op. cit. (92), especially pp. 351-2; Petersson, op. cit. (12), 223; Dockery, op. cit. (27), 124. White's contempt for the Jesuits (see p. 229 above) can be partially explained by their opposite views as to the meaning of counter-reform.
II

Atomism and Eschatology

It should now be recognised why White and Digby based their natural philosophy upon Aristotelian principles. For them, Aristotelianism was one of the traditions of the Catholic Church. In spite of their close association with original thinkers like Hobbes, Descartes, and Gassendi, they wanted to eschew originality and to pretend that their advanced mechanical philosophy was all to be found in Aristotle’s works. So, when Hobbes wrote that ‘Aristotelity’ was nothing other than ‘a handmaid to the Romane Religion’, he took it as a sufficient reason to reject Aristotle. For Digby and White, however, it was necessary, on the same assumption, to re-emphasize Aristotle. Just as Catholic theology was always inextricably linked with Aristotelian philosophy, Digby and White would have judged it fitting, and even inevitable, that their reformed Catholicism should be inextricably linked with their reformed Aristotelianism. In both areas there was nothing arbitrary about their reforms. Their natural philosophy, as much as their theology, was guided by tradition as well as by reason.

Further evidence that White believed he had rediscovered the true faith, to which all Christians should subscribe, is afforded by his determined opposition to the scepticism of the age. The most clear example of this can be seen in his debate with the Anglican Joseph Glanvill over the Vanity of dogmatising. For White, scepticism was the ‘Mother of Infinite Errors and all Heresies, and that very seducing Philosophy and vain fallacy which the Saints warned by the Apostles, have taught us to beware of’. Throughout his Answer to the vanity of dogmatising, therefore, White asserted that the ‘Digbæan method’ could solve all the problems of natural philosophy: the causes of motion, gravity, light, colours, and so on. And, more importantly, it could solve all the problems of the nature of the soul. White was confident in his rejection of scepticism because he believed he had found the incontrovertible truth which nowhere deviated from the scriptures, from the early traditions of the Church and its (Aristotelian) philosophy, or from the dictates of the most rigorous logic.

116 Ibid., 52.
117 Ibid., 30-3.
118 One of the most interesting manifestations of White’s belief that his rationalist natural philosophy was fully in agreement with scripture is to be found in his Theological appendix, of the beginning of the world. This appendix to his Institutionum periapateticarum, London, 1646 (English
The Blackloist counter-Reformation programme was an interesting development in its own right and would repay further study. Already, however, we should be able to see that one or two currently cherished historiographical positions need to be qualified in the light of this Catholic contribution to the early development of mechanism in England.

For example, although it is true to say that the Blackloist programme provides confirmation, from an unexpected quarter, of the importance of eschatological concerns during the period, it cannot be used to confirm Charles Webster's interpretation of how science and eschatology were affiliated.\textsuperscript{119} Essentially Webster's argument is that eschatological considerations stimulated scientific development as an important means towards 'social and intellectual progress'. Eschatology, therefore, is married to Baconianism in Webster's historiography and is said to promote 'the technical, utilitarian and ethical dimensions of science'.\textsuperscript{120} Now, Webster is only able to argue along these lines because he has concentrated on one rather special aspect of eschatology. Throughout \textit{The Great Instauration} Webster insists that 'Puritans' were expecting an imminent millennium: a thousand year rule of the Saints on earth during which time society would be transformed into a utopian paradise. The Puritans, therefore, turn to Baconian utilitarian science, he claims, as a necessary first-step towards the establishment of this utopian society.

In fact, Webster's argument relies for its force on an unfortunate failure to distinguish between two eschatological traditions. The millenarianism of which Webster speaks is only a very specialised version of more general ideas which should be called 'apocalyptic'. Admittedly there were those in seventeenth-century England who looked forward to an imminent paradise on earth, where all social injustice would be eradicated for a thousand years prior to the final Judgement Day. These thinkers were millenarians in the true sense, and it may well be that the major motivation behind such beliefs was, or gave way to, a desire for \textit{political reform}.\textsuperscript{121} However, the label 'millenarian' is all too often applied to other thinkers who (being happier with the \textit{status quo} perhaps) recognised the dangers inherent in such political cravings and who preferred to believe that the millennium was long past, or well under way, and even nearing its end.\textsuperscript{122} Such thinkers, secure in their self-conscious
piety, looked forward to the Day of Judgement itself, not what they would see as the more lowly aim of a political utopia. Their views are more correctly labelled as apocalyptic but amillennial.123

Unfortunately we do not have a census detailing which (or even how many) seventeenth-century thinkers were millennialist and which amillennialist. However, it is perfectly clear that the Blackloists were amillennialists. Their concern is only with the state of the human soul after death and after the resurrection of all the dead on the Last Day. There is absolutely no talk of a thousand year rule of the Saints on earth before the Judgement Day. So, it would be short-sighted (not to say blinkered) in the extreme to suppose that the Blackloist mechanical philosophy must have been developed in order to improve man’s lot on earth, as a first step to the founding of a utopian society. On the contrary, the Blackloists were concerned with a much more rarefied objective: the establishment of the true faith. They wanted to show that the bodily resurrection, foretold in the scriptures and emphasized in the early traditions of the Church, was in keeping with the third and final rule of faith—reason. Their mechanist physics was developed, then, in order to give philosophical backing to the concept of the resurrection. Their natural philosophy affirmed that the resurrection of the body was not only philosophically sound but philosophically necessary.

Similarly the other leading figure in the early development of the mechanical philosophy in England, Thomas Hobbes, also paid great attention to eschatological concerns. In the final part of *Leviathan* Hobbes discussed the immortality of the soul and the state of affairs after the Last Judgement. There is, however, no discussion of the millennium.124 Indeed, perhaps it should be added that the prevalence of mortalism during this period tends to suggest that a significant number of thinkers from John Donne and Thomas Browne to Richard Overton, Hobbes and


123 P. Toon (ed.), op. cit. (43), 17, distinguishes between premillennialism, postmillennialism and amillennialism. Paul Christianson, op. cit. (43), 7, however, warns that these and other distinguishing terms are in danger of causing even greater confusion. I can readily agree with this and I must express my gratitude to Dr. Colin Russell for helping me to make sense of these abstruse matters. Christianson recommends the use of the wider term ‘apocalyptic’ and reserves the term ‘millennial’ (or ‘millenarian’) to refer to the notion of a future, collective, imminent transformation of life on Earth. B. S. Capp is always careful to distinguish between apocalypticism and millenarianism and, essentially, I am in agreement with his position. See, B. S. Capp, *Godly rule and English millenarianism* and ‘The millennium and eschatology in England’, in C. Webster (ed.), op. cit. (1), 386–98, and 427–34. There is one small point of difference between us, however. His characterisation of apocalypticism as ‘pessimistic’ and millenarianism as ‘optimistic’ (ibid., 387) is completely subjective and seems to illustrate what could be called ‘unbeliever’s chauvinism’. Dr Capp seems to be incapable of seeing that a godly man could look forward to the Last Day with great optimism.

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Milton were more concerned with the Last Day than they were with any thousand year preamble. 125

Providing we bear in mind the distinction between true millenarianism and more general apocalyptic ideas, millenarianism begins to seem less significant than Webster would have us believe. Because Webster believes that most seventeenth-century natural philosophers are simply millenarian, and therefore expecting some sort of political utopia under the rule of the Saints on earth, then it makes perfect sense for him to suppose that they were fired to develop a utilitarian science which then became an indispensable feature in the march of progress. However, if we take the more correct view that most natural philosophers in the period were anticipating the Day of Judgement when all social and political aspirations would be suspended once and for all, then Webster’s supposition seems far less persuasive.

In the conclusion to The Great Instauration Webster claims that he has tried ‘to explore the relevance of Puritanism to the investigation of the natural world in terms of contemporary priorities’. 126 It would seem that he has not quite lived up to this ambition. In fact he has exaggerated the role of political utopian motivations (presumably his own priorities) at the expense of more strictly religious motivations. The millenarian-utilitarian-utopian tradition which Webster has charted was undoubtedly significant, but injudicious use of the word ‘millenarian’ should not be allowed to obscure a separate tradition. 127 That there was a profound interdependence between apocalyptic but amillennial eschatology and the mechanical philosophy is clearly shown by the work of Digby and White. But their work is only the earliest in a tradition later adopted, or rather adapted, by thinkers like Robert Boyle, John Evelyn, Thomas Burnet and others. 128


126 Webster, op. cit. (3), 505.

127 A number of other writers have allowed themselves to be confused by failing to make the necessary distinction between apocalypticism and millenarianism. For example, J. R. Jacob, Robert Boyle and the English revolution: a study in social and intellectual change, New York, 1977, 125, notices that Boyle is too orthodox a thinker to desire the political revolution implied in millenarianism and yet he continues to speak of Boyle’s ‘millenarianism’ throughout the book. Similarly, M. C. Jacob, The Newtonians and the English revolution, 1689–1720, Hassocks, 1976, 104 and elsewhere, seems surprised to find ‘millenarianism’ advocated by many orthodox thinkers. In fact there is no contradiction: the orthodox thinkers she mentions looked forward to the complete destruction of their world followed by the establishment by God of a ‘new heaven and a new earth’ in which they would be living eternally in heavenly bliss. This is not a political vision but a religious one and it is definitely not millenarianism. Burnet, therefore, was not millenarian (contrary to her statement at p. 116), nor was Hobbes (p. 104), and nor was Evelyn (p. 122). Christopher Hill, most recently in Some intellectual consequences of the English revolution, London, 1980, 58–61, also sees all shades of apocalyptic thought merely in terms of the ‘practical politics’ of millenarianism (p. 58) or in terms of a Baconian ‘theory of progress’ (p. 59).

128 Robert Boyle, Some physico-theological considerations about the possibility of the Resurrection, Works, London, 1772, iv, 191–202; Thomas Burnet, op. cit. (118); John Evelyn left among his manuscript papers, now at Christ Church, Oxford, a tract ‘Concerning the millennium’ (Evelyn MS 35) in which he insisted that he spoke ‘Not as the Millenaries of old’ about a thousand year period on this earth, but about an eternal period in a ‘Renewed Heaven and Earth to come’ (1:2). The visions of Burnet and
The Blackloist programme also tends to confirm the belief of many historians that the mechanical philosophy and its associated corpuscularian matter theory were first introduced into the main-stream of English natural philosophy in order to promote a particular ideological purpose. However, the fact that the ideology of Digby and White was neither Puritan, Latitudinarian nor Anglican means that the prevailing historiography has to be qualified yet again. With the addition of Catholicism to these other three religious ideologies it now seems even more obvious than it did before that the mechanical philosophy could be (and was) used to provide a philosophical foundation for almost any ideological standpoint.

It follows that the recent attempt to argue exclusively for 'the Anglican origins of modern science' by establishing 'the relation of matter theory to ideology' in the work of Robert Boyle during the Restoration period is totally inadequate. It can now be seen that Boyle merely had to follow the example set by Digby and White. The Blackloists had demonstrated clearly and explicitly how science could be used for ideological purposes long before the Restoration and it was all there for the taking. There can be no doubt that Boyle knew the work of these two Catholics. Digby had ingratiated himself to Samuel Hartlib in the early 1650s and may well have entertained hopes that the Blackloist theology would hold some appeal for Hartlib's circle, who were also keen to establish a unified Church.

The fact that the earliest overt attempt to use natural philosophy for ideological purposes was perpetrated by counter-reforming Catholics may also add to our understanding of the very real mistrust of the new philosophy shown by many thinkers. Among the factors which historians have already discerned in this mistrust are a reaction against the dogmatism of Descartes and Hobbes which seemed at the time to lead to materialism and atheism; and a reaction against the various kinds of natural philosophy which became associated with various radical and subversive sects in the revolutionary period. No historian could deny, however, that for most seventeenth-century Englishmen Roman Catholicism presented at least as big a threat to their society as atheism or enthusiasm. The machinations of the Blackloists, therefore, might lie behind Boyle's deliberate attempt to dissociate himself from the

Evelyn are similar in important respects to that of Hobbes who might also have been included in this list (see note 124 above).


130 Letter from Hartlib to Boyle, May 8, 1654, in Boyle, Works, vi, 87. On ecumenism in Hartlib's circle see, for example, J. M. Batten, John Drury: advocate of Christian reunion, Chicago, 1944. Drury was one of the leading members of the circle.

ideological use of natural philosophy in his *The excellency of theology compared with natural philosophy*. In this work Boyle tries to assert the necessity for revealed religion and to deny the possibility of using natural philosophy to prove the truths of religion. Boyle tries to argue his case by considering an example which is very reminiscent of Digby’s claims:

If we can prove, by some intellectual operations of the rational soul, which matter, however modified, cannot reach, that it is a substance distinct from the human body, there is no reason why the dissolution of the latter should infer the destruction of the former, which is a simple substance, and as real a substance as matter itself, which yet the adversaries (Epicureans) affirm to be indestructible. 132

Boyle denies the forcefulness of such arguments by pointing out that God may have so ordained, that though the soul of man, by the continuance of his ordinary and upholding concourse, may survive the body, yet . . . it shall be annihilated, when it parts with the body, God withdrawing at death that supporting influence which alone kept it from relapsing to its first nothing. Whence it may appear, that not withstanding the physical proofs of the spirituality and separableness of the human soul, we are yet much beholden to divine revelation for assuring us, that its duration shall be endless. 133

Generally speaking Boyle’s discussion is framed as a critique of Cartesianism but on this particular matter he absolves Descartes. It is Digby who is the real perpetrator of such a dogmatic philosophical theology. Descartes himself denied the possibility of proving the immortality of the soul by rational means and spoke only as a probabilist:

And that you may not doubt of this I will give you for it his own confession as he freely writ it in a private letter to that admirable lady the princess Elizabeth . . . who seems to have desired his opinion on that important question, about which he sends her this answer, *Pour ce qui &c*, i.e. As to the state of the soul after this life my knowledge of it is far inferior to that of monsieur (he means Sir Kenelm) Digby. For, setting aside that which religion teaches us of it, I confess, that by mere natural reason we may indeed make many conjectures to our own advantage, and have fair hopes, but not any assurance. 134

The ideological use of the new philosophy by the Blackloist Catholic faction may also have prompted, at least in part, Henry Stubbe’s attacks on the Royal Society as a crypto-Catholic enclave. 135 In a series of pamphlets published in 1670 Stubbe vilified the Royal Society on a number of grounds. Considering the anti-Catholic feelings which raged throughout the Restoration period it is quite likely that the most damaging

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of Stubbe's accusations was that the Royal Society was bent on introducing 'a Popish implicit faith'. Stubbe's major reason for this belief was spelled out in his *Campanella reviv'd*. He alleged that the encouragement to study natural philosophy was a plot to distract the greatest minds while the Roman Church sought to re-establish itself. It is quite clear that he associated the Blackloists with such plots because he referred explicitly to 'the doctrines of Mr. White, Dr. Holden, Serenus Cressy, and such others as endeavour at present (and that with great show of wit and artifices) to seduce the English to that Apostaticall Church'. Although White was never a fellow of the Royal Society, Sir Kenelm Digby was and Stubbe made a point of denouncing him as 'the Pliny of our age for lying'.

In view of the virulence of anti-Catholic feeling in England during the Interregnum and the Restoration it is hardly surprising that Digby and White failed to persuade their fellow countrymen that they had rediscovered the true faith. Indeed, the Jesuit scholar, R. I. Bradley has forcefully argued that the Blackloists unwittingly eroded what remained of the Catholic Church in England and brought it to its final collapse. The final irony is the fact that no matter how far they compromised themselves in the eyes of their mother church, Digby and White were still regarded fearfully as Catholics by English Protestants. In spite of the willingness of the Blackloists to deny the secular power of the Pope, and in spite of White's explicit denial of Papal infallibility in his *Tabula suffragiales* of 1665, Digby was still said to have 'pursued nothing with so much vehemence as the establishment of Popery in England', and Thomas White was always regarded as 'the great Papist'.

140 R. I. Bradley, op. cit. (10) and (92).
141 R. I. Bradley, op. cit. (10) and (92).
142 Thomas White, *Tabula suffragiales determinandis fidei ab ecclesia catholicae fixae...*, London, 1655. White's denial of Papal infallibility was by no means as unprecedented as many of his other beliefs. In fact it was a much disputed opinion within the Roman Catholic Church at that time.
OCCULT QUALITIES AND THE EXPERIMENTAL PHILOSOPHY: ACTIVE PRINCIPLES IN PRE-NEWTONIAN MATTER THEORY

Right from its inception at the beginning of the seventeenth century the mechanical philosophy was beset with problems. In part, this was an inevitable result of the hubris of the early system builders, Descartes, Gassendi, Digby and Hobbes. Each of these thinkers wanted to substitute their own particular system for the moribund scholasticism in which they were trained, believing that their principles were capable of explaining all natural phenomena in a way that was far clearer and more easily intelligible than any peripatetic accounts. The easy intelligibility was held to result from the fact that the mechanical philosopher "made use of sensible principles such as are matter, Locall Motion, Magnitude, figure, situation &c. so that when hee speakes, it is possible to understand what he means". As is well known, however, the attempt to explain all phenomena in terms of the rearrangement in space or change of motion of invisible corpuscles of matter soon ran into insuperable difficulties. The analogy between familiar, everyday phenomena and the microstructure of matter soon ran into superstructure difficulties. The analogy between familiar, everyday phenomena and the microstructure of matter, which seemed simple and plausible at a superficial glance, broke down very rapidly under close scrutiny.

One of the most fundamental objections to the mechanical philosophy gave rise to a scepticism about the possibility of causal explanations based on 'communication by impulse'. Scepticism on this matter is usually associated with David Hume but it can be traced back much earlier. The scholastic trained contemporary of Descartes would need to know how motion, a quality or mode of individual bodies, could be transferred from one body to another simply
because their bodies came into contact. When Henry More considered the Cartesian account of the transference of motion he felt obliged to interpret it in a quasi-vitalistic way:

I feel more disposed to believe that motion is not communicated, but that from the impulse of one body another body is so to speak roused into motion, like the mind to a thought on this or that occasion, and that the body does not take as much motion as it needs for movement, being reminded of the matter by the other body....

More reiterated this interpretation some years later in 1655:

... he [Descartes] is fabricating some kind of life in that when two bodies meet, he is able to accommodate their motions so that each of them, notified by the other, the one about acceleration of its motion, the other about retardation of its motion, finally agrees on the same course of motion. And it is the same thing for the other laws of transport. For Descartes himself scarcely dares to assert that the motion in one body passes into the other .... But since no motion passes from one body into another, it is manifest that one arouses the other from sleep as it were, and in this way aroused bodies transfer themselves from place to place by their own force; which property of bodies I consider as some shadow and image of life.4

Underlying this and many similar objections from a number of leading philosophers was the conviction that a system of natural philosophy based solely on a concept of passive, inert matter endowed only with the ‘passive power’ of its inertia, could not possibly work.5 Nevertheless, it is usually assumed that the mechanical philosophy carried on along Cartesian lines, in which explanations were couched in terms of the behaviour of totally passive particles of matter moving either inertially or as a result of the impulse of other particles of passive matter in motion, until the advent of Isaac Newton. As every historian of science ‘knows’, the essentially unworkable mechanical philosophy was transformed by the genius of Newton who re-introduced ‘occult qualities’ into natural philosophy. The triumph of the mechanical philosophy was assured once it was accepted that the system of the world was invested with unexplained active principles, forces and powers which could even operate at a distance. The brilliant stroke of incorporating ‘occult qualities’ into the mechanical philosophy has frequently been cited as further evidence of Newton’s supreme genius. For example, in a recent essay Professor Westfall has argued that Newton’s concept of attractive and repulsive forces operating between distant particles was “a major revision” or “a major philosophic innovation” which derived from “the conviction that nature cannot be reduced to the arrangement of inert particles of matter”. From the late 1670s Newton moved “steadily away from
the orthodox mechanical philosophy", we are told, and increasingly relied on secret principles of motion and the belief that "Nature contains foci of activity, agents whose spontaneous working produces results that cannot be accounted for by the mechanical philosophy's only category of explanation: particles of matter in motion".6

Efforts to trace the intellectual origins of Newton's concept of active principles have tended to concentrate either on the influence of alchemy or of Cambridge Platonism on his thinking.7 The evidence in support of these analyses seems unassailable but they do not provide the full picture. What is in danger of being overlooked is the influence of Newton's older English contemporaries in natural philosophy. The historiographical emphasis on the radical revisionism or innovatory nature of Newton's concept of occult active principles and the concentration on non-mechanist sources of influence like alchemy tends to perpetuate the view that English mechanical philosophy before Newton followed the essentially unworkable Cartesian programme in which matter was completely inert and could only act by virtue of its 'force of motion' in collision with other parts of matter. However, once we lay aside all false preconceptions about the equivalence of Cartesianism and mechanism and about the transcendent genius of Isaac Newton, we can see that English mechanical philosophers before Newton at the very least entertained the possibility of unexplained active principles or 'foci of activity' in matter and very frequently relied upon them quite explicitly.

In the first section of this paper, therefore, I will give a brief survey of some of the ways in which English mechanical philosophers tried to overcome or rather circumvent the perceived philosophical objections to a strict version of the mechanical philosophy (as exemplified by Cartesianism) by introducing unexplained active principles, and occult qualities into matter theory. Much of what I say will be familiar. Indeed, even Westfall, in an earlier paper, has insisted that the mechanical philosophy was "pervaded with conceptions, disguised by mechanistic veneers, that can only be explained as descendants from the Hermetic tradition". By the (perhaps unfortunate) phrase "Hermetic tradition" Westfall meant that philosophy which habitually referred to occult qualities, and he found hints of this way of philosophizing in Descartes, Boyle and John Mayow. Even so, I believe it is worth restating this in a synoptic way in order to restore the balance to a Newtonian historiography which has recently become hard to disentangle from hagiography.8 I do not intend to attempt a systematic and definitive account of active principles in pre-Newtonian mechanical philosophy. In a sense, to do so would be to write the entire history of seventeenth century English natural philosophy. However, even this brief discussion should suffice to show that Newton's version of the mechanical philosophy was not so radically different from that of his fellow countrymen. Furthermore, we will be able to see that English mechanical philosophers provided Newton not only
with many hints towards his own recension of the mechanical philosophy but also with a ready made and crucially important methodology upon which he could draw to defend his natural philosophy from the attacks of Continental Cartesians.

In the second and third sections of the paper I will try to reinforce my claim that the use of active principles in pre-Newtonian matter theory represents a clear and undeniable tradition in English mechanical philosophy and cannot be dismissed as nothing more than a series of minor aberrations by the writers involved. So, in the second section I try to suggest why active principles played such a prominent part in seventeenth century English natural philosophy. Active principles, I contend, could be used to avoid the theological difficulties which were perceived to stem from systems of passive matter moving merely inertially. If God was no longer required to supervise the running of the universal machine, the atheist might argue that God had never been required since the universe may have existed eternally. The demonstration of active principles in matter could be used to forestall such atheist gambits. At the same time, the natural philosophers' insistence that such active principles could be investigated and described by their techniques ensured that the supernaturalism of religious enthusiasts could not assert itself as the truest account of the world. On the contrary, the mechanical philosopher could present his work as the safest way to understand God's creation and, therefore, as an essential ingredient of true religion.

One of the most important aspects of the mechanical philosophers' attempts to claim that their natural philosophy provided a 'true' and objective account of the world, as a number of historians have recently shown, was the emphasis on the experimental method. The experimentalist could claim that he was revealing only 'facts' about the world, which anyone else could confirm by following the same simple procedures. His work was, therefore, largely free from the bias inherent in all efforts to explain the world along preconceived rationalist lines. The defence of the experimental method as the safe way to truth and thereby the safe way to salvation can be regarded as one of the most characteristic features of seventeenth century natural philosophy. In the third and final section of this paper I argue that the claims about the possible existence of occult active principles in matter was an important aspect of the promotion of the experimental method. The occult qualities or principles of matter, so important for understanding the true nature of God's creation, could only be evinced, it was claimed, by experimental procedures. Thus, the professed belief in occult qualities came to be amalgamated with or embedded into other arguments in defence of the experimental method. For example, I argue that the recent claims for the importance of traditional voluntarist theology in the establishment of the experimental method can be reinforced by looking at the links forged by
seventeenth century mechanical philosophers between voluntarist theology and the concept of intrinsically active matter.

**THE ACTIVITY OF MATTER**

Without so much as a hint of braggadocio Descartes announced at the end of *Principia philosophiae* that "there is no phenomenon in nature that is not comprised in what has been explained in this treatise". Not all his readers were convinced. Among those everyday phenomena which immediately presented themselves to these Cartesian doubters were gravity, magnetism, cohesion (why do the particles of bodies stay together?) and 'spring' (why do the particles of air or vapours stay apart?). However, perhaps most fundamental of all was the problem of motion. Those thinkers who accepted Descartes's rules for the transference of motion from one particle to another and his belief that the total amount of motion in the universe was always constant were simply taking it on trust: nothing was really explained. Other thinkers, therefore, preferred to join More and Leibniz in their belief that the transference of motion implied some kind of active or even vital principle in matter. Besides, there were a number of physical phenomena which seemed incompatible with Descartes's claim that there could be no generation of new motions in the universe. Transference of a fixed quantity of motion from one body to another may seem easy to envisage in simple mechanical systems but it is difficult to imagine how it can explain some quite common chemical phenomena. If heat is simply a manifestation of the seething motions of invisible corpuscles then how are we to explain the supposed increase in particulate motions when two cold liquids mix to give an exothermic reaction? The explosive origin of new motions seems hard to deny when gunpowder is ignited, and surely men and animals initiate new movement merely by exercising their will?

Newton's response, as we all know, was to argue that there must be occult active principles in the world to initiate and preserve motions. As he wrote in Query 31 of the *Opticks*:

> The *Vis inertiae* is a passive Principle by which Bodies persist in their Motion or Rest, receive Motion in proportion to the Force impressing it, and resist as much as they are resisted. By this Principle alone there never could have been any Motion in the World. Some other Principle was necessary for putting Bodies into Motion; and now they are in Motion, some other Principle is necessary for conserving the Motion.

Active principles, he insisted, were necessary to "conserve and recruit" motion, "For we meet with very little Motion in the World besides what is owing to these active Principles". It is clear from the full context of these remarks that
Newton was setting up these ideas in opposition to Cartesianism. In so doing, however, he was merely repeating ideas which were common to other versions of the mechanical philosophy.

We can illustrate this by considering what is, as far as we know, the earliest attempt to develop a fully elaborated system of mechanical philosophy by an English thinker. Walter Warner (1570-1642/3) arrived at his mechanical philosophy by blending elements from the neo-Platonism of Medieval and Renaissance naturalists with ideas from his mentor Thomas Harriot and Galileo. He based his system on four metaphysical principles, three passive, one active. This is how he introduced his active principle:

... neither time and space at one, nor time and space with matter are sufficient without the position of some fourth thing for the production of all the species, motions, alterations and affects which are actually apparent in the universe. Some such fourth thing is therefore to be admitted ... as none of these [phenomena] that are in motu (as they all are) can possibly be salved by the solitary existence of matter we must of necessity acknowledg a fourth thing as a cause of motion which may therefore well be termed vis or power by the quality of his office.

Warner’s active principle or “cause of motion” is variously referred to as *vis radiativa* or “vertue radiative” and we are told that “All bodies have in them an efficient power or vertue.”

Warner’s system was never published although his papers are known to have influenced the thinking of a number of natural philosophers in the first half of the seventeenth century. So, for a discussion of active principles in matter which is known to have been read by Newton perhaps we should turn to Walter Charleton’s *Physiologia Epicura-Gassendo-Charltoniana*. Charleton, closely following Gassendi, accepted the Epicurean notion that matter contained an inherent principle of motion. Needless to say, he dissented from the Epicurean belief in the eternity of the atoms and their inherent motions but otherwise the story is the same: “at their creation God invigorated or impregnated” atoms “with an Internal Energy or Faculty Motive, which may be conceived the First Cause of all Natural Actions or Motions”. “Atoms are never totally deprived of their essential Faculty, Mobility”, he tells us, “and from that foundation is it that all Concretions derive their Virtue Motive”. Putting it another way:

That same MOTIVE VIRTUE, therefore, wherewith every Compound Bodie is naturally endowed, must owe its origine to the innate and co-essential Mobility of its component particles...

The major source for Charleton’s ideas in the *Physiologia* was, of course, Pierre Gassendi whose matter theory was strongly influenced by the Paracelsian Petrus Severinus, and managed to reconcile materialism and vitalism.
Charleton embraced Gassendi's version of the new philosophy only after making his own eclectic reconciliation of atomism and Helmontianism. In the Preface to his translation of Van Helmont's *Magnetick cure of wounds* Charleton explained the curative efficacy of the "powder of sympathy" in terms of the "imperceptible Emissions steaming in a semi-immaterial thread of Atomes". He justified this claim on the grounds that

by a general consent of all the secretaries of Nature, and the undeniable testimony of trivial Experience, every mixt Body, of an unctuous composition doth incessantly vent, or expire a circumferential steam of invisible Atomes.

His image of all unctuous bodies incessantly "steaming" derives from his professed belief, reminiscent of Warner's, that matter is "richly endowed" with a "radial activity". This radial activity is elsewhere referred to as "the secret power of Natural Actives". Similarly, in his early essay in natural theology, *The darkness of atheism dispelled by the light of nature*, Charleton was clearly repudiating contemporary Cartesianism when he wrote that only "impardonable incircumspection or forgetfulness" could account for the belief that matter is "absolutely idle, and devoid of all motive or active virtue". For Charleton the "native Tendency", "the faculty of self-motion" inherent in atoms, was an essential element in his proof of the existence of God. The strict version of the mechanical philosophy, in which matter was entirely passive (as in the systems of Descartes and Hobbes), was held by Charleton and by others, as we shall see, to provide too much encouragement to atheism.

The same general approach to the ontological problem of motion can be seen even in a minor thinker like the virtuoso Sir Matthew Hale. Hale was essentially a conservative eclectic who wanted to save the best parts of the scholastic system by giving it a mechanistic gloss. In his *Observations touching the principles of natural motions* of 1677 we can see that he too, like Warner, Charleton and Newton, adopted the premise of active principles in matter on the grounds that matter in itself is essentially passive:

Matter it self simply considered as such, though it be susceptive of Motion (as we daily see) is not the immediate principle of Motion in those subjects that seem to be self-moving ....

Therefore if there be any things in Nature, that have their Principle of Motion in themselves, we must find out if we can, somewhat besides Matter, that is the immediate root or spring of it.

The analysis of a particular body in terms of substance and accidents is inadequate Hale suggested, and immediately he moved to his desired conclusion:
There seems therefore to be a third kind of Existence or Entity participating in some respect of the nature of both [substance and accident] and yet differing in other respects from both; for indeed it is an Entity among created Beings belonging to Matter, far more noble than either of the two former, and is that which giveth Life, Vigor, Activity and Motion, immediately next under the Lord of Nature to every self-moving Being.

Like Warner, Hale dubbed this entity which belongs to matter \( \text{vis} \):

And this entity I call \( \text{Vis} \) or \( \text{Virtue activa} \), superadded to Matter, and giving immediately those motions to it, that are specifically appropriate to that \( \text{Vis} \) or \( \text{Virtus activa} \), and without which, Matter would be stupid, dull, unactive, and always at rest in itself unless accidentally moved \( \text{ab extrinseco} \).

He went on to distinguish a hierarchy of \( \text{virtues activae} \) and the least noble of these, which are found in the mineral realm, he called “active qualities”. Even these “movenf principles”, however, can be said to give “a kind of Life ... to the Subject wherein they exist”. As Newton was to write in a draft query for the \( \text{Opticks} \) (in about 1705), “We cannot say that all nature is not alive”.21

These three thinkers, then, Warner, Charleton and Hale, provide us with very clear examples of the belief in the necessary existence of active principles in English mechanical philosophy. Warner writing before 1630, Charleton in the 1650s and Hale in the 1670s all believed that the essentially passive nature of matter could not “save the phenomena” of everyday experience (in spite of the fact that they all knew the principle of inertia). Accordingly, they each developed, in their different ways, a concept of active principles which inhere in matter, having been superadded to it by God. The fact that three such different thinkers developed broadly similar concepts of active principles in matter should surely indicate that there may be a clear tradition of active principles in English matter theory at this time. It is the contention of this paper that there was indeed just such a tradition. Of course, the mechanical philosophy in seventeenth century England was not a monolithic entity: each natural philosopher had his own way of developing the basic enterprise of explaining everything in terms of “matter and motion” and might cherish his own particular solution to this or that problem. Nevertheless, a constant ingredient in English mechanical philosophy was one variety or another of active principle superadded to matter. It would seem likely, therefore, that a number of the ingredients in this rich broth of ideas would provide food for Newton’s thought.

Consider, for example, Henry Power’s concept of active spirit. Power averred that motion “is as inseparable an attribute to Bodies, as well as Extension is” and insisted, therefore, that “there can be no rest in Nature more than a Vacuity in matter”. He admitted that the origin of this motion was “one of the obscurest
things in Nature” but his favoured explanation relied on an inherently active material spirit which was “the main (though invisible) Agent in all Natures three Kingdoms Mineral, Vegetal and Animal”. This spirit was held to be composed of “subtle particles” and was diffused “throughout the Universe”, pervading all other bodies and so producing the motions of inanimate matter and the vital activity in physiological processes. It is important to note that Power’s concept of an active spirit is unequivocally materialistic and, as Charles Webster has shown, it does not derive from the speculations of the Cambridge Platonist, Henry More, but is in fact influenced by Paracelsian doctrines and the speculations of his friend, Francis Glisson, on the intrinsically “energetic nature of substance”. Power’s speculations about an active material spirit appeared in print in his Experimental philosophy in 1664, and so predate Newton’s own alchemical musings in his “Propositions” (c. 1669) about a “mercurial spirit ... dispersed through all places”. Similarly, we can compare Power’s pervasive active “subtle particles” with the subtle active matter invoked by Newton in his “Vegetation of metals” in the early 1670s. Here Newton suggested that some very subtle and therefore pervasive kind of matter was inherently active and could activate “grosser matter”:

the immediate seat of ... operations is not the whole bulk of the matter but rather an exceeding subtle and unimaginably small portion of matter diffused through the mass, which, if it were separated, there would remain but a dead and inactive earth.

Newton’s subtle active matter is linked in his thoughts to the traditional biomedical concept of flamma vitalis and more recent theories of the role of fermentation in vital processes:

This is the subtle spirit. This is Natures universall agent, her secret fire, ye only ferment & principle of all vegetation. The material soule of all matter....

Here again Newton’s private thoughts seem to echo ideas which had already been published by iatromechanists like Thomas Willis, Richard Lower and John Mayow. Willis and Mayow developed corpuscular systems of philosophy which assumed from the outset a hierarchy from active matter down to passive matter; from spirit and sulphur (Willis) or sulphur and mercury (Mayow) to earth. Different combinations of the various kinds of particle, Willis suggested, gave rise to “Ferments” which were responsible for initiating and conserving many vital processes, and which in adverse circumstances could cause many pathological conditions. Neither Willis nor anyone else try to explain the operation of fermentation in strict mechanical terms, the motions of the “ferment” are simply assumed:
Fermentation is an intestine motion of Particles ... the Elementary Particles being stirred up into motion, either of their own accord or Nature, or occasionally, do wonderfully move themselves, and are moved; do lay hold of, and abvolve one another....

Similarly, "the cause of Fermentation" is simply included by Newton in his list of "active Principles" without which "the Bodies of the Earth, Planets, Comets, Sun and all things in them, would ... become inactive masses".

Newton's indebtedness to such biomedical ideas was very nearly made public in his "Hypothesis of light" sent to be read at the Royal Society in 1675. Some time after sending his speculative "Hypothesis" to Oldenburg he wrote to ask the secretary of the Royal Society to strike out the suggestion that "the forms of nature may be nothing but aether condensed by a fermental principle". Nevertheless, the "Hypothesis" as it appeared in print spoke freely of "the vital aereal spirit, requisite for the conservation of flame and vital motions", and of a "humid active matter". The "Hypothesis of light" is perhaps closest in its overall impression to John Mayow's philosophy of active 'nitro-aerial' particles. Indeed, the similarities are so striking that even Professor Westfall has remarked upon them. For Westfall, however, Mayow's introduction of occult active principles into the mechanical philosophy was a self-delusion because he "did not explore the apparent contradiction of an active principle in the context of a mechanical philosophy of nature". However, it should be clear from what has been said here that this "contradiction" may be apparent to Westfall but it would not have been to an English contemporary of Mayow's. The mechanical philosophy, as it was presented by English natural philosophers, had a strong tradition of active principles.

Robert Boyle who admitted to being "so shy of laying down principles, and sometimes of so much as venturing at explications" was usually non-commital about the theoretical presuppositions underlying his work. Nevertheless, here and there even he acknowledged the need to call upon active principles. A significant example of this is provided in a letter which Boyle wrote to Hartlib sometime before 1660 but which he only chose to publish right at the end of his life in *The general history of the air* (which, in the event, appeared posthumously in 1692). Like Power, Willis and Mayow, Boyle here assumed the existence of "aerious, etherial, luminous" spirits in "all mixed bodies". These spirits are material and "the only principles of energy, power, force and life, in all bodies wherein they are, and the immediate causes through which all alteration comes to the bodies themselves". In his *Suspicions about some hidden qualities in the air* (1674) Boyle talked of "a little vital quintessence" or "some vital substance" in the air. On more than one occasion he speculated that this vital factor, rather than being reducible to the "mechanical affections" of matter, may be "of solar, or astral or some other exotic nature". If Boyle was careful not to use the
phrase “occult qualities” in his title to this work he made it clear enough in his preface that they were what concerned him:

I began some years ago to set down a collection of some new or less heeded observations and experiments relating to the causes and effects of changes in the air, which I referr’d to several heads, ... the last of which was of the occult qualities of the air, supposing there be any such.

While the material gathered by Boyle under some of the other “heads” had to remain unsorted and unpublished, he felt it was “unfit, that anything should perish, that related to so considerable and uncommon a subject, as that of this title”.31

In his *Cosmical qualities of things* (1671) Boyle suggested that there may be “a new set of faculties (or powers) and dispositions” which “depend upon some unheeded relations and impressions which these bodies owe to the determinate fabrick of the grand system or world they are part of”. It is possible that this new set of faculties may be “saved” to give a strictly mechanistic reading although it seems to me to hint to rather more “exotic natures”. Certainly, the appendix to this work provides us with speculations which cannot be reconciled to strict mechanism. In “Cosmical suspicions” Boyle admitted that some natural phenomena may not be explicable in terms of the “mechanical qualities” of size, shape and motion because they are caused by “particular sorts of corpuscles that have yet no distinct name, which may discover peculiar faculties and ways of working”.32 Elsewhere, he proposed that various “saline substances” may be produced by “some internal thing, that is analogous to a Seminal Principle”, and that precious stones may have an “expansive endeavour” or “some Principle of growth” inherent in them.33

Even when Boyle confined his explanatory efforts to the familiar principles of matter in motion he did not subscribe to a strictly mechanistic account in which there is no new motion but only redistribution of motion by impact. When Boyle considered the ways in which a very small motion may “tricker” major physical effects we can safely assume that he was casting doubt on the Cartesian notion of simple transference. Boyle’s “wonder” at the shaking of the earth and the firm buildings upon it simply at the passing of a cart, for example, made him suspect that this little stimulus caused the earth “to tremble it self”.34 Similarly, Boyle’s account of an experiment in *Certain physiological essays* (1661) prompted a Cartesian like Spinoza to object that Boyle seemed “to wish to show ... that the particles of salt carry themselves into the air by their own impulse”. Boyle merely replied that he had “made use of the Epicurean principles, which have it that motion is innate in the particles”. In so doing Boyle, like Charleton, Willis and all others of a Gassendist persuasion, laid himself open to the charge that he was relying upon an occult quality in matter which outdid “the most
credulous Peripatetics”. For, as Edward Stillingfleet objected, in his *Origines sacrae* of 1662, to say that “Atoms move because it is their nature to move” is least of all pardonable in the exploders of substantial forms and occult qualities when the Origine of the whole world is resolved into an occult quality which gives motion to Atoms.35

If Boyle ever got ‘steamed up’ about such charges he might have repeated his words in *The excellency and grounds of the corpuscular or mechanical philosophy* (1674): “I see not, why a philosopher should think it impossible, to make out, ... the mechanical possibility of any corporeal agent, how subtle, or diffused, or active soever it be ....” After all, the *Materia Subtilis* of the Cartesians is, to all intents and purposes, no less active “than the universal spirit of some spagyristes, not to say, the *Anima Mundi* of the Platonists”. Accordingly, we frequently see Boyle assuming, for heuristic reasons, that bodies are composed of corpuscles with an inherent vibratory or oscillatory mode. This enabled him to say, for example, that bodies may “owe their elasticity not so much to their structure as their [intestine] motion”. The expansion of air upon application of heat, then, takes place because

heat, that is a kind of motion may make the agitated particles strive to recede further and further from the centres of their motions, and to beat off those that would hinder the freedom of their gyrations, and so very much add to the endeavour of such air to expand itself.

Newton adopted the same idea in his “Hypothesis of light” when he proposed that “the aether is a vibrating medium like air” but “more strongly elastic”.36

The natural philosopher to make the best use of the concept of incessantly and innately vibrating matter, however, was Robert Hooke. Like Boyle he did not try to explain the vibrations of matter as the result of a series of impacts, he simply made it an *ad hoc* feature of his world system:

Now that the parts of all bodies, though never so solid do yet vibrate, [Hooke wrote], I think we need go no further for proof, then that all bodies have some degrees of heat in them, and there has not been yet found any thing perfectly cold: Nor can I believe indeed that there is any such thing in Nature, as a body whose particles are at rest, or lazy and inactive in the great Theatre of the World, it being quite contrary to the grand *Oeconomy* of the Universe.37

In his cosmological speculations Hooke used such inherent vibrations of matter (specifically, of the interplanetary aether) to explain light and gravity which he regarded as “the most considerable and most active principles in Nature”. The fact that he explained these “active principles” in terms of mechanical vibrations in a universal aether was hardly likely to impress those
who demanded a system as rigorously mechanical as Descartes's. In answer to the question, why was the aether incessantly vibrating? Hooke simply reverted to his concept of unexplained vibrating matter:

Suppose then there is in the Ball of Earth such a Motion, as I, for distinction sake, will call a *Globular Motion*, whereby all the parts thereof have a Vibration towards and fromwards the Center, or of Expansion and Contraction; and this vibrative Motion is very short and very quick, as it is in all very hard and very compact Bodies.38

Perhaps we would be closer to Hooke's way of thinking if we spoke of 'pulsations' rather than 'vibrations'. Henry More, writing in 1651, asked the Platonic enthusiast Thomas Vaughan to show him the heart whose systole and diastole produced "the pulse of the world". It would seem that he might have been justified in asking Robert Hooke the same question.39

Marie Boas Hall, in her "Establishment of the mechanical philosophy", characterized the new philosophy in terms of the banishment of "sympathies and antipathies, congruities and incongruities, attraction and hostility".40 And yet we do not have to proceed very far into Hooke's first major work, *Micrographia*, in order to find him explaining a phenomenon by reference to "congruity" and "incongruity". This obvious use of an occult quality in the work of the supreme experimental philosopher has not shaken the prevailing historiography of the mechanical philosophy represented here by Marie Boas Hall. Historians have been quick to point out that Hooke provided a *mechanical* explanation of congruity and incongruity. The fact that this explanation once again relied on the concept of incessantly vibrating matter does not seem to have been registered. Besides, Hooke himself tells us that his experimental demonstration of congruity and incongruity (showing the spontaneous separation of sand from fine gravel when placed on a "nimbly beaten" drumhead) did "not come up to the highest property of Congruity, which is a Cohaeision of the parts of the fluid together, or a kind of attraction and tenacity". Similarly, the highest property of incongruity would, presumably, be a kind of repulsion.41

This cannot be dismissed as a trivial failure on Hooke's part to give a satisfactory mechanical explanation of a particularly difficult problem. He went on to develop the concept of incongruity as "a coefficient in the most considerable Operations of Nature". This entered most dramatically into his speculations when he considered the existence of an all pervasive and universally incongruous aether as an explanation of gravity. Hooke asked

whether the Phaenomena of gravity might not by this means be explained, by supposing the Globe of Earth, Water, and Air to be included with a fluid, heterogeneous to all and each of them, so subtil, as not only to be every where interspersed through the Air (or rather the air through it) but
to pervade the bodies of Glass, and even the closest Metals, by which means it may endeavour to detrude all earthly bodies as far from it as it can; and partly thereby, and partly by other of its properties may move them towards the Center of the Earth.42

This universally incongruous subtle fluid may well have provided a model for Newton's aether speculations. Newton postulated an aether which was "much rarer" within dense bodies than in seemingly empty space. The resulting density gradients in the universe could then be invoked to explain gravitational attraction: "every Body endeavouring to go from the denser parts of the Medium towards the rarer." In earlier aether speculations Newton had even written of "a certain secret principle in nature, by which liquors are sociable to some things, and unsociable to others".43

Hooke’s universally incongruous aether with its occult power of detrusion or repulsion may seem, at first glance, to be no less remarkable a flight of fancy than Newton’s own "non-mechanical" aether.44 However, we do not have to search too far for a likely source of inspiration. Robert Hooke had a very clear and very familiar exemplar of a fluid whose parts seemed to detrude one another to a remarkable extent. Investigation of this fluid and its capacity for expansion was to engage the intellects of some of the leading mechanical philosophers in England: Hooke himself, Robert Boyle, Henry Power, Sir William Petty and John Mayow.

In 1647 Roberval had shown that a carp's bladder, sealed in a deflated or collapsed state, would expand dramatically, becoming taut as though ready to burst, when placed in a Torricellian vacuum.45 So began a major effort to understand the mysteries of the 'spring' of the air. Boyle and Hooke were able to manifest many similar examples of this springiness by means of their air-pump. In all cases it seemed that the air was behaving exactly like the material spirits invoked by iatromechanists like Charleton and Willis with their "endeavour to expand themselves, and flye away".46 The problem for a corpuscularist, like Boyle, was to determine

how, since the corpuscles of the air are acknowledged to be heavy, and those that remain [after operation of the pump] must be so wonderful thinly dispersed in the cavity of the receiver, they come to be supported and kept, as it were, swimming therein, and do not appear to subside by their own weight, the Materia subtilis (though the presence of that should be admitted) not appearing to have gravity wherewith to sustain them; and the vacuum (if that be supposed wherever the aerial particles are not) being too near a-kin to nothing to be able to oppose their descent....47

This was essentially a very old problem. Atomist or corpuscularist attempts to explain material properties like weight or density in terms of the packing, or
distribution in space of the constituent particles of matter had been rejected by Aristotle on the grounds that it would require what he called “self-determined voids”. What Aristotle meant by that is, perhaps, most strikingly illustrated by the contemporary Aristotelian, Sir Kenelm Digby, writing in 1644:

If such vacuities [between particles] were the cause of rarity, it would follow that fluid bodies being rarer than solid ones, they would be of themselves standing, like nettes or cobwebbes: whereas contrariwise, we see their natures are to runne together, and to fill up every little creek and corner: which effect, following out of the very nature of the things themselves, must needs exclude vacuities out of their nature.

The initial response to such objections was simply to allow that matter was structured like “nettes or cobwebbes”. Boyle imagined particles of air like tiny springs or like strands of wool which were usually compressed by gravity but could expand when pressure was reduced. Similarly, Newton, even as late as the 1690s, was willing to concede that there must be “a certain wonderful and exceedingly artificial texture of the particles of bodies ... like networks”. Elsewhere he wrote of net-like figures, textures and particles. However, as we know from his manuscript fragment entitled De aere et aethere, written about 1679, Newton had already conceived of the possibility that “air is composed of the particles of bodies torn away from contact, and repelling each other with a certain large force”. Newton’s “Suspicious about the cause of this repulsion” were that “God may have created a certain incorporeal nature which seeks to repel bodies” or “that corpuscles may be surrounded by a sphere of most fluid and tenuous matter which admits other bodies into it with difficulty” – what Hooke would call an incongruous fluid.

Professor Westfall has seen these “Suspicions” as “a major revision in the prevailing mechanical philosophy”. For Westfall

The significance of the redirection of his philosophy of nature undertaken about 1679 can scarcely be overstated. What he proposed was an addition to the ontology of nature. Where the orthodox mechanical philosophy of seventeenth-century science insisted that physical reality consists solely of material particles in motion, characterised by size, shape and solidity alone. Newton now added forces of attraction and repulsion, considered as properties of such particles, to the catalogue of nature’s ontology.

However, within the context of English mechanical philosophy, Newton was not making such a radical innovation. In fact, the structural explanations of the spring of the air, in terms of the extension and compression of long spring-like particles was very quickly dismissed as unsatisfactory by English mechanical philosophers. The expansion of the air due to the uncoiling or straightening out of compressed particles seemed increasingly implausible when experiments with
the air-pump showed that the air's "Elasticity is of a vast, and almost unlimited
nature, that scarce hath any bounds to it".\textsuperscript{53}

One reaction to this, as we have seen with Robert Boyle, was to try to explain
the spring of the air in terms of increased vibrations of its particles. However,
such increased frequencies and amplitudes of vibration were themselves utterly
mysterious since it was recognized that air could and did expand itself without
the help of any stimulatory input of other rapidly moving particles, such as
particles of fire. As Sir Matthew Hale objected, there was a common notion
among natural philosophers

that if we should suppose any part of the Universe were free from any
Body, or had a more subtle Body than that of the common Air, if a
portion of the lower Air next the Earth were placed there, it [the air] would
upon the account of its own natural Elasticity, expand it self as largely,
and it may be much larger than those Artificial Expansions wrought by
fire in Aeolipiles, and other Engines....\textsuperscript{44}

Such a remarkable capacity for self-expansion envisaged within a corpuscularist
frame of reference virtually forced the conclusion that particles of air were able
to spread themselves apart in space so that a body of air could be said to contain
what Aristotle quite aptly referred to as "self-determined voids". As early as
1652, therefore, Charleton had included the power of repulsion, along with
spring ("resilition") in a list of the innate properties of atoms:

Atoms, in the instant of their creation received immediately from God a
faculty of self-motion, and consequently of concurring, crowding, justling,
repelling, resilition, exsilition, and reciprocal complectence, concatenation,
revinction, \&c. according to the respective preordination in the
Divine Intellect.\textsuperscript{55}

Furthermore when Sir William Petty tried to explain "Springing or Elastique
Motions", that "hard Rock in Philosophy ... Which has long lain thwart Us in
the way of Our Enquiries", his whole approach took for granted ideas that
Newton was later to consider using for the "Conclusio" to his \textit{Principia
mathematica}. Newton assumed that there is an "analogy of nature" so that

Whatever reasoning holds for greater motions, should hold for lesser ones
as well. The former depend upon the greater attractive forces of larger
bodies, and I suspect that the latter depend upon the lesser forces, as yet
unobserved, of insensible particles. For, from the forces of gravity, of
magnetism and of electricity it is manifest that there are various kinds of
natural forces, and that there may be still more kinds is not to be rashly
denied. It is very well known that greater bodies act mutually upon each
other by those forces, and I do not clearly see why lesser ones should not act on one another by similar forces.\textsuperscript{56}

This could almost be seen as a defence of Petty's speculations, published over ten years earlier in 1674, that "every Atome" is "like the Earths Globe or Magnet, wherein are three Points considerable, viz. two in the surface called Poles, & one within the substance, called Center, or rather Byass".\textsuperscript{57} Petty went on to suggest that, by virtue of its magnetic nature, an atom "may move about his own Axis, and about other Atoms also, as the Moon does about the Earth; Venus and Mercury about the Sun; and the Satellites Jovis about Jupiter &c." Petty's atoms were modelled upon William Gilbert's conception of the Earth as a huge spherical magnet. Arguing just like Newton from an analogy between large and small, Petty supposed that "the Byas [centre of gravity] of one Atome may have a tendency towards the Byas of another near it", and that

all Atoms have, like a Magnet, two motions, one of Gravity whereby it tendeth towards the Center of the Earth, and the other Verticity, by which it tendeth towards the Earths-Poles, and whereby Magnets joyn to each other by their Opposite Poles.\textsuperscript{58}

It is important to mention here that there is absolutely no question of a Cartesian, mechanistic account of magnetism underlying Petty's theories. He does not believe that magnetic phenomena are brought about by sub-microscopic passive particles shaped like tiny screws and moving merely inertially. For him, the sub-microscopic particles, such that "perhaps a Million do not make up one visible Corpusculum", are themselves magnets. Each atom, therefore, must exhibit the same 'occult qualities' that we see so strikingly in the familiar magnet, including the occult qualities of attraction and repulsion.\textsuperscript{59}

It would seem, then, that the frequent historiographical claims about Newton's radical revision of the mechanical philosophy are somewhat exaggerated. The belief that Newton invigorated the mechanical philosophy by impregnating matter with occult qualities in the form of 'foci of activity', active principles, unexplained faculties and virtues, secret principles of sociability and unsociability and forces of attraction and repulsion, fails to do justice to the fruitful tradition of English mechanical philosophy of which Isaac Newton was a part. Whatever the reactions of Continental natural philosophers to Newton's use of 'occult qualities', not one English mechanical philosopher raised his voice against it. Newton's work did not strike his older contemporaries in England as a dramatic break from their own enterprise. For them the \textit{Principia} was not only a dazzling display of intellectual virtuosity it was also a vindication of their own general approach to the problems of natural philosophy.
WHY ACTIVITY MATTERS

So far we have simply pointed to a few scattered details in the philosophies of a small number of mechanists in seventeenth century England. In order to show that these represent a genuine tradition in mechanical philosophy to which Newton was the heir, we must consider, if again only briefly, the broader context of English natural philosophy. We have already noted that the strict version of the mechanical philosophy, as expounded by Descartes, was represented as implausible on philosophical grounds by a number of thinkers. The general tenor of these arguments was that completely passive matter and a system which did not allow for the generation of new motion in the world could not possibly “save the phenomena”. However, we must not forget also the influence of natural theological concerns and the peculiar fears of atheism, irreligion or dangerous heterodoxies in early modern England.

As is well known the mechanical philosophy was pioneered in England by thinkers who saw it as a powerful support for their religious views. The most vigorous early advocate of Cartesianism in England, for example, was the theologian Henry More who believed that the new French system was “the best Engine” against “erroneous fabricks in Religion” he had ever seen. However, More’s evangelical interpretation of Descartes’s philosophy was somewhat idiosyncratic. As we have already seen from his response to the Cartesian notion of transference of motion by impact (quoted above), More insisted that Descartes assumed the existence of some kind of active principle in matter which, given the essential passivity of matter, testified to the existence of God.60 More was to bitterly regret his naivety some years later when he realized that the strict mechanical system of Descartes had been taken up by “atheistical wits” and “mere scoffers at religion”. By then, too, there was a home-grown system of mechanical philosophy, rivalling Descartes’s in its strictness and eschewing all active principles, which constituted the natural philosophy of the most notorious ‘atheist’ in England: Thomas Hobbes’s De corpore.61

If More’s religious preoccupations and his desire to use Cartesianism in defence of his theology made him slow to see that Descartes’s theories could just as easily be used by contemporary ‘atheists’, other readers were quick to realize the dangers implicit in the Cartesian approach. If the world system was so contrived that once God set it in motion it could continue indefinitely without his further intervention, then it was easy to imagine that God was not necessary at all. Aristotelians and Epicureans alike had argued that the world had always existed and so, when Descartes had seemingly removed the necessity for Aristotle’s continually operating “first (or unmoved) mover”, it was easy to suppose that the world system had exhibited the kinds of motion and change we daily see throughout eternity.
In order to avoid providing such a hostage to atheism Newton argued that by the passive principle of \textit{vis inertiae} alone "there never could have been any Motion in the World", and so God would be required to provide motion even if the world \textit{had} existed eternally. Boyle made the point clear in a refutation of Lucretius:

he supposes his eternal atoms to have from eternity been their own movers, whereas it is plain that motion is no way necessary to the essence of matter, which seems to consist in extension .... And accordingly I finde that \textit{Anaxagoras}, though he believed, as Aristotle did after him, that matter was eternal, yet he discern'd that the notion of matter not necessarily including motion, there was a necessity of taking in a \textit{mens}, as he stiles God, to set this sluggish matter a moving.

In other words, the atheist stratagem of proclaiming the world to be eternal can only be successful, Boyle was saying (and speaking for many of his fellow naturalists), if motion is a \textit{logical} concomitant of matter in the same way that extension is. The fact that it is not, since matter can be conceived without contradiction to be at rest, necessarily implies that God gave activity to it.\textsuperscript{62}

Of course, Descartes himsell tried to forestall any atheistic conclusions from his theories but he used a very different gambit. He engaged God to continually maintain matter in motion from moment to moment — a theological expedient which was emphasized subsequently in Malebranche's occasionalist interpretation of Cartesianism.\textsuperscript{63} However, this kind of move was regarded with some suspicion by both theologians and natural philosophers in England. Isaac Barrow, for example, was thinking of Descartes when he wrote: "he speaks unworthily of the Supreme Maker of things who supposed that he created just one homogeneous Matter and extended it blockish and inanimate." What was "unworthy" in this was God's continual labouring with the dross of the world as a mere "carpenter or mechanic repeating and displaying \textit{ad nauseam} his one marionettish feat".\textsuperscript{64} For Joseph Glanvill and Henry More this kind of divine immanence was even problematic when considering high level activities like the infusion of souls into unborn foetuses let alone the interactions of base matter. If God was required to animate, by creation of a new soul, every newly conceived foetus in the womb then He would have

To bear a part amongst Pimps and Bawds, and pocky Whores and Whoremasters, to rise out of his Seat for them, and by a free Act of Creation of a Soul, to set his Seal of Connivance to their Villainies....

Clearly, God the puppetmaster would have to be regarded as a Cosmic accessory before, during and after the fact.\textsuperscript{65}

Amongst natural philosophers, on the other hand, appeal to a \textit{Deus ex machina} was generally frowned upon as a betrayal of their tradition and a
relinquishment of natural philosophy's claim to reveal God's plan in the Creation. As Boyle pointed out in his examination of The vulgarly receiv'd notion of nature (1686), when a philosopher "can say little" in answer to questions

but that it pleased the Author of the Universe to make them so ... we pretend not to give the particular physical reasons of the things propos'd, but do in effect confess we do not know them.

The alternative, then, was to insist that God created the world in such a way that his intervention was unnecessary. "It much more tends to the Illustration of God's wisdom", Boyle wrote, "to have so fram'd things at first, that there can seldom or never need any extraordinary Interposition of his Power". The wisdom of God, Boyle reiterated, is most clearly demonstrated when the philosopher can show that God

... can make so vast a machine, perform all those many things which he designed it should, by the meer contrivance of brute matter, managed by certain laws of local motion, and upheld by his ordinary and general concourse.66

For Boyle, and for English natural philosophers, a continuous recreation of the world from moment to moment would require the extraordinary or absolute power of God. By contrast, the notion of the world as a vast Automaton consisting of matter endowed with principles of activity and operating exclusively in accordance with the Laws of Motion required only that God should play a supervisory role. Thus the world is said to be contrived like the Strasbourg Clock rather than

... after the nature of a puppet ... such, that almost every particular motion the Artificer is fain (by drawing sometimes one wire or string, sometimes another) to guide, and oftentimes over-rule the actions of the engine.67

Charleton considered it a major philosophical advantage of his system that

... it fitly declares the radical Cause of all Motion, activity or energie in second causes, or natures once removed from the Primus motor, God.

Similarly, Sir Matthew Hale believed that

... it far more advanceth the glory of the Divine Wisdom, in that he hath setled such a regular order in things of Nature, that may regularly conduct them to their designed end; then if the Glorious God, or any intelligent Power by him substituted, should by immediate and identical interposition produce every Phaenomena in Nature.68
The concept of active principles, therefore, enabled the natural philosopher to account for the physical phenomena without recourse to the perpetual miracle of God's direct intervention. Although Newton, ignoring Christopher Wren's indulgent smile, sometimes felt compelled by his religious obsessions to attribute the cause of gravity directly to God, he always reverted to more naturalistic explanations before too long. 69

The most vigorously proposed alternative to active principles in matter as an intermediary between God and the world was Henry More's concept of the 'Spirit of Nature'. The reactions of natural philosophers to More's notion show not merely a marked aversion to supernaturalism but also an unmistakable desire to dissociate themselves from More's way of using philosophy to bolster his somewhat idiosyncratic religious opinions. 70 Boyle, Hooke and Haie felt it was necessary to put their refutations into print; but More himself tells us that even before any of these appeared he had been charged:

That I have introduced an obscure Principle for Ignorance and Sloth to take Sanctuary in, and so to enervate or foreslack the useful endeavours of curious Wits, and hinder the expected progress that may be made in the Mechanick Philosophy; and this, to aggravate the crime, before a competent search be made what the Mechanical Powers of Matter can doe.

More's attempts to rebut this charge in 1662 made no impression on Hooke who made the same point some fifteen years later. The concept of the Spirit of Nature, Hooke wrote, "tends to nothing but the discouraging industry from searching into and finding out the true causes of phenomena". "What should I trouble myself", he went on, "to enquire into that which is never to be understood". 71 Underlying these criticisms was the natural philosophers' belief, which we shall return to in the next section, that active principles, for all their occult nature, were amenable to philosophical investigation while the Spirit of Nature was not. As Sir Matthew Hale put it:

the substitution of such a vicarious, immaterial, common Principle, ... subordinate to Almighty God, a common Spirit, and different from the particular active principles variously implanted in Physical Bodies, though it be a pleasant supposition, yet it is difficult if not impossible to evince to any tolerable satisfaction. 72

The critical response of natural philosophers to such religiously inspired supernaturalism is perfectly clear but, it should hardly need saying, their critiques could only be advanced with care. The fear of atheism and irreligion ran high throughout this period and it was all too easy for a philosopher to find his ideas tarred with the brush of atheism. The efforts of English natural philosophers to avoid such imputations and to establish the "usefulness" of natural philosophy are well known and we need not rehearse them here except
in so far as they relate to their use of active principles. However, we must mention one aspect of this tension between religion and science which is germane to our story since it has had historiographical as well as historical consequences.

One of the major reasons behind More's development of the notion of the Spirit of Nature was to avoid the concept of animated, or merely active, matter. His response to Descartes, quoted earlier, in which he seems to suggest his own belief in matter endowed with "some shadow and image of life" was really only loose talk. Even at that early stage (1649-55) More usually wrote in terms of a categorical distinction between matter, which is inactive, and immaterial spirit, which is active. In his earliest writings, however, he was often (as in these early responses to Descartes) lax in his manipulation of these categories. After 1656, however, More tightened up his thinking and henceforth was always insistent on the categorical dichotomy of matter and spirit. One of the reasons for this was his increasing awareness of the dangers of "enthusiastic" beliefs in animate matter. More's *Brief discourse of ... enthusiasm* of 1656 was based on the premise that "Atheism and Enthusiasm, though they seem so extremely opposite one to another, yet in many things do nearly agree". Enthusiastic beliefs in animate matter, therefore, were likely to have dangerous consequences. The actual enthusiastic beliefs which More recorded were

That Nature is the body of God, nay God the Father, who is also the World, and whatsoever is any way sensible or perceptible.

And

That everything has *Sense, Imagination, and a fiducial Knowledge* of God in it, *Metalls, Meteors* and *Plants* not excepted.

The significant thing to notice about these beliefs is that matter is said to be not merely active but *perceptive* and in some sense *intelligent*. More sought to oppose these views by insisting on the distinction between dead matter and living spirit but during the course of strengthening his position and hardening his arguments he had to insist more and more upon the total passivity of matter. Before long he was not only opposed to ideas of perceptive matter but also to any claims about activity or innate motion within matter.

More was very influential among Anglican theologians and his aggregation of concepts of animated and merely active matter was, to say the least, embarrassing for one or two of the leading mechanical philosophers. Certainly Boyle was always very careful to deny that matter could think or display percipience or appetite. Moreover, so great was his reluctance to offend the sensibilities of Churchmen that, whenever he could without compromising his natural philosophy, he wrote as though matter was entirely passive. Similarly, Isaac Newton, when writing to the theologian Richard Bentley, felt obliged to deny that
gravity was inherent in matter ("Pray do not ascribe that notion to me"); but was perfectly willing (when writing in the *Opticks*, for a different audience) to imply that gravity and other active principles were powers or virtues of body.77

However, not all natural philosophers were so intimidated by the arguments of More and those theologians who followed him on this issue. Francis Glisson, Regius Professor of Physick at More's own university, even went so far as to take ideas about percipient matter which were current in the medical tradition to their logical conclusion. He developed a complete system of natural philosophy based on *The energetic nature of substance*.78 Similarly, John Locke, another writer educated in the contemporary medical tradition, felt no compunction to avoid the attribution of the power of thought to matter as a superadded property.79 Boyle and Newton, by contrast, each with his own reasons for avoiding religious controversy, show clear signs in their writings of speaking for the occasion; sometimes using active principles in matter to argue indirectly for God's existence and sometimes insisting that passive matter can only be moved by a divine agent. The ambivalence of these two most remarkable seventeenth century natural philosophers has had unfortunate historiographical consequences. It has tended to reinforce the simplistic view of seventeenth century matter theory, challenged here, in which matter is held to be passive and inert; and the consequent belief that Newton, for all his seeming hesitation, was the first to introduce active principles into the mechanical philosophy. Moreover, it has even led to what might be seen as a historiographical revival of Henry More's tendentious views in which believers in active matter are, *ipso facto*, held to be subversive radicals while believers in passive matter (a category which, in this revival, is made to embrace virtually every mechanical philosopher in England) are conservative defenders of Church and Crown.80 In fact, as we have seen, a professed belief in occult qualities and active principles in matter was certainly a legitimate stance for a seventeenth century natural philosopher to take up; and often this kind of matter theory was used to bolster the image of the natural philosopher as natural theologian.

To recapitulate, then, active principles could be claimed to be an essential feature of sound natural philosophy not just for philosophical reasons but also on natural theological grounds. On the one hand they were used to undermine the atheistic interpretation of strict mechanism — that the universe may always have existed with the same amount of motion it now has. As Warner, Charleton, Hale, Boyle and Newton pointed out, passive matter alone could never have given rise to the motions we see in the world, and so God would be required to provide activity even if the world was eternal and uncreated.

On the other hand, active principles provided a series of hypothetical physical entities which fulfilled a useful explanatory role and were susceptible to philosophical investigation. They therefore prevented the heterodox and blasphemous invocation of God as a continual agent immanent in matter and, only
slightly less inimical to natural philosophers' concerns, the overrunning of natural philosophy by supernaturalism.

THE MATTER OF ACTIVITY

When Westfall suggested that Newton's triumph in mechanical philosophy was dependent in part on the radical innovation of introducing occult qualities or active principles into mechanist matter theory, he felt the need to say something about Newton's defence of these supposedly outlandish ideas. Newton, after all, "was well aware that he was proposing a major philosophic innovation" and so "he tried to shield himself from expected criticism". This defence included recourse to mathematical realism and an insistence that the truths of natural philosophy could be arrived at phenomenologically in spite of causal nescience. This latter point was made most famously in Query 31 of the *Opticks*; defending the concept of active principles he wrote,

> These Principles I consider, not as occult Qualities, supposed to result from the specifick Forms of Things, but as general Laws of Nature, by which the Things themselves are form'd; their Truth appearing to us by Phaenomena, though their Causes be not yet discover'd. For these are manifest Qualities and their Causes only are occult.⁸¹

Similarly, I. B. Cohen has recently argued that perhaps the most revolutionary feature of Newton's *Principia* is its elaboration of a new style of mathematical physics. Professor Cohen's analysis and exposition of the 'Newtonian style' is complex and subtle and cannot be summarized here.⁸² Suffice it to say, however, that one of the philosophical intentions of the Newtonian style, as Cohen sees it, is to justify a phenomenological position in the face of causal nescience. So, although Newton's critics believed his system was based on "a return to the 'occult qualities' which had supposedly been cast out of natural philosophy", Newton himself replied that

> In this philosophy particular propositions are inferred from the phenomena and afterward rendered general by induction.... And to us it is enough that gravity does really exist and act according to the laws which we have explained, and abundantly serves to account for all the motions of the celestial bodies and of our sea.

This remains sufficient, Newton insisted, even though he has "not been able to discover the cause of those properties of gravity from phenomena, and I frame no hypotheses".⁸³

Both Westfall and Cohen seem to imply that this methodological ploy was essentially a new move, developed by Newton to protect his uniquely original
philosophy. This is not so. Just as Newton was able to draw on the earlier tradition of English mechanical philosophy for his concept of active principles, so he was able to draw on it for precisely the same kind of phenomenological defence of occult qualities we have just seen. Indeed, this phenomenological approach to the understanding of nature is one of the most characteristic features of seventeenth century English natural philosophy and dovetailed neatly with the other stratagems used to bolster the claims of the new science to establish moral certainties. The frequently proclaimed Baconianism of English natural philosophy, its refusal to deal in mere hypotheses (made famous by various spokesmen for the Royal Society) its mitigated scepticism and its emphasis on experimentalism are all inextricably bound up with, if not derived from, its practitioners' acknowledgment of the impossibility of finding what Joseph Glanvill called "the first springs of natural motions" unless, of course, we simply mean God. A natural philosophy (leaving God out of our considerations) which depends on active principles is, essentially, one which must remain aetio logically incomplete. Not all the causal processes underlying physical interactions can be explained, some must remain inscrutable. Nevertheless, the enterprise of natural philosophy need not be abandoned. Though it may be impossible to explain how an occult active principle works it will always be possible (providing it is real) to show that it "does really exist".

So, the existence of "a Magnetick way of curing wounds by anointing the weapon" could be accepted by mechanical philosophers since, as Joseph Glanvill averred, it was "for matter of fact put out of doubt by the Noble Sir K. Digby". Glanvill's subsequent summary of Digby's mechanistic explanation of "this wonder" is highly favourable and larded with praise. And yet in the end Glanvill suggests that causal explanations are less important than establishing the fact:

It is out of my way here to enquire whether the Anima Mundi be not a better account, then any Mechanical Solutions. The former is more desperate, the latter hath more ingenuity, then solid satisfaction. It is enough for me that de facto there is such an entercourse between the Magnetick unguent and the vulnerated body, and I need not be solicitous of the Cause.

Observation and experimental evidence are thus given primacy over causal hypotheses. This attitude even enables Glanvill to entertain the possibility of action at a distance. For example, although a "sympathetic" telegraph involving needles, magnetized by the same magnet, pivoted over "Abecadarian circles"

May not yet answer the expectation of inquisitive experiment; yet 'tis no despicable item, that by some other such way of magnetick efficiency, it
may hereafter with success be attempted, when Magnetical History shall be enlarged by riper inspections. 

We can see very similar ways of thinking in Boyle’s writings. In *The usefulness of experimental natural philosophy*, for example, Boyle considered how one might explain the “pretended Sympathy” between gold and quicksilver:

> the Naturalist may explicate, by saying, That Gold being the onely Body heavier than Quick-silver of the same bulk, the known Laws of Hydrostatics makes it necessary that Gold should sink in it, and all lighter Bodies swim on it: But though the cause of this effect be thus plausibly assign’d by deducing it from so known and obvious an affection of Bodies, as Gravity, which every man is apt to think he sufficiently understands; ... yet the Cause and Nature of it [gravity] are as obscure as those of almost any *Phaenomenon* it can be brought to explicate.

Boyle’s conclusion to this discussion is simply to acknowledge “an intelligent Author or Disposer of Things”, but then this is an avowedly apologetic work. Elsewhere he is content to agree with “Archimedes, Stevinus and others” who “do not take it upon them to assign the true cause of gravity but take it for granted, as a thing universally acknowledged that there is such a quality in the bodies they treat of”. And on the equally difficult problem of ‘spring’ Boyle took a similarly phenomenological position when he insisted that his intention was not “to assign the adequate cause of the spring of the air, but only to manifest, that the air hath a spring, and to relate some of its effects”. Speaking of ‘spring’ in general, he insisted that

> whatever the latent Cause of the Phaenomena may be, the manifest Circumstances of them suffice to show, that bodies, which, as to sense, are in a natural state of Rest, may be in a violent one, as of Tension, and may have, either upon the score of the contexture of the parts among themselves, or upon that of some interfluent subtile matter, or some other Physical Agent, a strong endeavour to fly off or recede from one another....

Spring was, in other words, what Newton would call a manifest quality of which the cause was occult.

In 1716 Leibniz accused Newton of introducing “a chimerical thing, a scholastic occult quality” into his natural philosophy but Boyle was anticipating and responding to such changes as early as 1671:

> And least you should think that under the name of Cosmical Qualities I should introduce Chimaeras into Natural Philosophy I must betimes advertise you, that you will meet with divers Particulars in the following Discourse, fit to show that these Qualities are not meerly fictitious
Qualities: but such, whose Existence I can manifest, not only by considerations not absurd, but also by real Experiments and Physical Phaenomena.  

For Robert Hooke it was permissible to introduce “unheard of Powers, Operations, Effects or Motions” into natural philosophy providing they are all “within our reach and command”, so that the experimenter can “daily try, see, and find the regular working of” them. Sir William Petty felt that his “Hypothesis of springing or elastique motions” avoided “Chymerical Speculations” because

My matter is so simple, as I take notice of nothing in each Atome, but of three such Points as are in the Heavens, the Earth, in Magnets, and in many other Bodies. Nor do I suppose any Motions, but what we see in the greater parts of the Universe, and in the parts of the Earth and Sea. This in turn ensured that Petty’s hypothesis was amenable to experimental investigation:

all the motions I fancy in my Atoms, may be represented in gross Tangible Bodies, and consequently may be made intelligible and examinable.  

Clearly Boyle was not the only natural philosopher who believed it was possible to
discourse like a naturalist about magnets of celestial and other emanations, that appear not to have been consider’d, not to say, thought of, either by the scholastic, or even the mechanical, philosophers.

To discourse about ‘latent qualities’ or ‘occult qualities’ could be useful to “the sagacious and inquisitive”, in Boyle’s opinion, providing the naturalist confined himself to ‘matters of fact’ or undeniable, everyday phenomena susceptible to experimental manipulation.  

The experimental method, therefore, could be insisted upon by English natural philosophers as essential for the development of the mechanical philosophy and its companion, natural theology. As Keith Hutchison has recently shown, the mechanical philosophers regarded it as one of the supreme advantages of their new philosophies that they could accommodate occult qualities in a heuristically useful way. The scholastic distinction between ‘occult’ and ‘manifest’ qualities, Hutchison points out, became inappropriate when all phenomena were explained in corpuscularian terms. A manifest quality for scholastics was one which could be immediately apprehended by the senses. Yet the whole thrust of the new philosophies was to explain all physical change in terms, ultimately, of the insensible motions or powers of insensible particles. All secondary qualities thus became occult.  

If many causal explanations must,
therefore, remain elusive, it was nevertheless possible to establish, experimen-
tially, the richness of natural effects. What the experimental method could do, in
spite of causal nescience, was establish the ‘matters of fact’.

Once we accept Hutchison’s analysis it becomes easy to see why Newton
could treat occult qualities as epistemologically equivalent to ‘metaphysical’,
‘physical’ and even ‘mechanical’ qualities when composing the General Scho-
lium for the *Principia* in 1713. Newton’s efforts to persuade his readers that he
did not feign hypotheses were not simply a matter of eschewing all occult
qualities. On the contrary, hypotheses were defined as “whatever is not deduced
from phenomena”, and this could apply equally well whether one talks of
“Metaphysical or Physical, whether of occult qualities or Mechanical”. The
converse of this is that occult qualities are just as acceptable in natural
philosophical explanations as metaphysical, physical or mechanical qualities,
provided they can be demonstrated or deduced “from phenomena”. Gravity,
therefore, is an occult quality which is not hypothetical because it can be shown
that it “does really exist”.95

Given the widespread use of such phenomenological arguments in late
seventeenth century England it seems reasonable to assume that Newton felt, as
he said in another context, he had said enough for people to know his meaning.
After 1716, however, he began to think that perhaps he had not. It was at the
beginning of 1716 (new style) that Newton learned of Leibniz’s dismissal of
Newtonian gravity as an occult quality, or to be precise, “une qualité occulte
scholastique”. In Newton’s reactions to this charge, a lot hinged upon Leibniz’s
use of the qualifier ‘scholastic’. His first reply, to the go-between Abbé Conti,
made the point forcefully:

> He [Leibniz] changes the signification of the words Miracles & Occult
qualities that he may use them in railing at universal gravity ..., occult
qualities are decried not because their causes are unknown, but because
the Schoolmen believed that those things wch were unknown to their
Master Aristotel, could never be known.96

The point is, of course, that Newton is every bit as opposed to “scholastic occult
qualities” as Leibniz is, but for Newton that adjectival phrase has a very
different “signification” from unqualified “occult qualities”, which he takes (in
the English sense) to be unobjectionable. It is presumably for this reason that
Newton added an anti-Aristotelian *rider* to his phenomenological defence of
occult qualities in the 1717 edition of the *Opticks*. Having said that active
principles are “manifest Qualities, and their Causes only are Occult”, Newton
wrote:

> And the Aristotelians gave the Name of occult Qualities, not to manifest
Qualities, but to such Qualities only as they supposed to lie hid in Bodies,
and to be the unknown Causes of manifest Effects: Such as would be the
Causes of Gravity, and of magnetick and electrick Attractions, and of
Fermentations, if we should suppose that these Forces or Actions arose
from Qualities unknown to us, and uncapable of being discovered and
made manifest. Such occult Qualities put a stop to the Improvement of
natural Philosophy, and therefore of late Years have been rejected.

Newton then felt able to reiterate his own way of using occult principles in
mechanical philosophy:

To tell us that every Species of Things is endow'd with an occult specific
Quality by which it acts and produces manifest Effects, is to tell us
nothing: But to derive two or three general Principles of Motion from
Phaenomena, and afterwards to tell us how the properties and Actions of
all corporeal Things follow from those manifest Principles, would be a
very great step in Philosophy, though the Causes of those Principles be not
yet discover'd.97

Newton's defence of occult qualities, then, is perhaps more sophisticated than
that of earlier English mechanists but it is not different in kind. His distinction
between occult qualities which can be deduced from phenomena and scholastic
occult qualities was foreshadowed in the writings of Charleton, Boyle, and Petty
and similar ideas were advocated by Glanvill and Hooke.98 The fact that occult
qualities in the mechanical philosophy have a history before Newton should
now be seen to be unsurprising. Indeed, the investigation and demonstration of
occult qualities in matter, as we have seen, were major factors in establishing
experimentalism as the safest and surest way to truth in natural philosophy.
Accordingly, the leading members of the Royal Society can be found trying to
promote various experimental research programmes as well as the various
Baconian 'natural histories' for which the Society is well known. Christopher
Wren, for example, lecturing to the Society in 1662 not only suggested the
compilation of a "History of Seasons" but also recommended the chemical
investigation of bodily fluids:

... in the Body of a Man, if we consider it only mechanically, we may
indeed learn the Fabric and Action of the organical Parts, but without
Chymistry, we shall be at a loss to know, what Blood, Spirits and
Humours are, from the due temper of which (as of the Spring in the Barrel
Wheel) the motions of all the Parts depend.

It is important to note, here, that although Wren uses a mechanical image —
"the Spring in the Barrel Wheel" — he is actually saying that there is a chemical
"Temper" of matter which is the cause of the matter's motion. Wren believed,
as Leibniz and Newton were later to do, that chemistry could enable us to
understand more fully what Glanvill called the "prime motive causes" in matter.\textsuperscript{99}

In a "List of Subjects for Essays" among his papers, Sir William Petty expressed his intention to write of "Vibrations and Pendulum", fermentations, magnets, "Of Ayre and Vacuum" and "Of the application of Gunpowder to other uses than guns". Each of these were regarded as fruitful areas of experimental investigation of the inherent activities of matter. We have seen, for example, how Hooke believed that all matter may be incessantly vibrating. It comes as no surprise, therefore, to learn that Hooke devoted much of his time to extensive experimental investigations of vibrations in springs, strings and pendulums. His metaphysics of vibrating matter may also lie at the root of his musical interests.\textsuperscript{100} No doubt Petty himself hoped that an intensive experimental investigation of magnetism could provide support for his hypothesis of magnetic atoms. The applications of gunpowder which he had in mind were, most probably, to do with its use in chemistry as a source of heat or energy and the use of "nitre" in the "oeconomy of nature", including physiological processes. The rich experimental research programme which focused on the role of nitre and culminated with John Mayow's nitro-aerial particle as "\textit{a primum mobile} of the physical world" was, as Robert Frank has shown, one of the most characteristic aspects of seventeenth century natural philosophy in England.\textsuperscript{101}

The attempts to investigate experimentally the supposed vibrations of matter, the incongruity of aether or the power of air to spontaneously disseminate itself through a vacuum, and the putative 'vital' ingredient of the air gave rise to the extremely fruitful and well-known investigations using the specially developed air-pumps. The importance of this experimental research programme for establishing the 'matters of fact' about occult qualities in matter cannot be overstressed. As works by Charles Webster, Robert Frank and Simon Schaffer make perfectly clear, the pneumatic experiments of Power, Boyle, Hooke and Mayow were intended not only to demonstrate the existence of spring but also to show the association between that occult quality and \textit{spiritus}, soul and vitality. Mayow, for example, interpreted a loss of volume of air (after burning a candle) as a diminution of the air's elasticity due to the consumption of nitro-aerial particles. Thus, the elasticity of the air was proposed as a measure of its inherent activity and vitalistic power.\textsuperscript{102}

Of course the experimental method was regarded by English mechanical philosophers as crucially important for a number of other reasons. Experimentalism was well suited to their mitigated sceptical response to the dogmatic excesses (as they saw them) of Roman Catholicism or sectarian enthusiasm. It was important to deny that explanations of physical phenomena could ever be proved apodictically in order to keep their natural philosophies from being commandeered by particular religious or political groups as an undeniable support for their world views. It was always possible, they therefore insisted,
that the machinery behind the clock face ran differently to the way men envisaged it. Accordingly, the most appropriate methodology for the mechanical philosophy seemed to most English natural philosophers to be not the implicitly dogmatic rationalism of Descartes or Hobbes but their own experimental method. Naturally, this promotion of the experimental method was not itself innocent of politico-religious intentions but with the emphasis on 'matters of fact' it could be claimed that it was. The importance of occult active principles in religious apologetics which we considered in the previous section and the insistence on the experimental method as the only way to establish the real existence of such occult principles, should be regarded therefore as one more facet of the ideological and apologetic use of the experimental method which has been analysed by Paul Wood, Steven Shapin, Simon Schaffer and others.

Another important element here is the traditional connection between natural philosophy and voluntarist theology. The voluntaristic belief that God can do anything that is not logically impossible merely by the exercise of his will led to a conviction that whatever order and structure there is in the world is not inherent in the nature of things but is merely contingent upon God's fiat. It follows that any attempt to deduce the system of the world by a process of pure reasoning is misconceived. The only way to discover the system of the world, on this view, is by an empirical investigation of the world as it has been created. As Oakley has pointed out, an empiricist approach to natural philosophy must follow from a belief in the "omnipotence and freedom of God". The opposite view, known as necessitarianism, argues that God is constrained, not only by the laws of logic but also by notions like Justice and Goodness, to create only one possible world — the best. According to the necessitarian the order in the world is immanent within it and can be analysed by a process of pure reasoning.

The use of voluntarist theology in defending a concept of active matter is clearly discernible in writers like Charleton, Boyle, Petty and Glisson. The argument was succinctly stated by that famous underwriter of experimental philosophy, John Locke:

> For I see no contradiction in it, that the first eternal thinking Being should, if he pleased, give to certain Systems of created senseless matter, put together as he thinks fit, some degrees of sense, perception, and thought.

While Locke saw no contradiction in it Glisson built his whole system of philosophy upon the assumption that God had given matter the powers of perception and self-movement. As we might expect, he believed that his theories could be confirmed by experiment and hoped that the Royal Society would undertake the required research programme. Glisson's views, however, drew the anger of theologians like More and Cudworth who perceived them as providing
hostages to atheism. Boyle seems to have agreed with the theologians on this matter and he was always careful to deny that matter could perceive and think. It should be noted, however, that Boyle, voluntarist that he was, did not deny that God could endow matter with such powers. He merely argued that experience showed that God had not done so. More and Cudworth, on the other hand, rejected the very possibility of perceptive or living matter as a logical absurdity. They could only do this, though, because they rejected voluntarist theology and embraced necessitarianism. This, in turn, drew the attention of the theologian, Richard Baxter, who repudiated More’s necessitarianism in a spirited defence of Glisson’s theory of perceptive matter. “I confess”, Baxter wrote, “I am too dull to be sure that God cannot endue matter itself with the formal virtue of Perception: ... Where is the contradiction that makes it impossible?”

Francis Oakley and Steven Shapin have both suggested that voluntarist theology is a key to understanding the social and political uses of early modern science. If we accept this then the fact that voluntarist theology was frequently used to insist that God by his arbitrary will could endow matter with intrinsic active principles of motion should reinforce the argument presented here, that active principles were an important part of the mechanical philosophy even before Newton. Thus, when Newton sought to defend his concept of automotive light particles in his “Hypothesis of light” of 1675, he could immediately invoke this voluntarist tradition. When he wrote, “God, who gave animals self-motion beyond our understanding is, without doubt, able to implant other principles of motion in bodies, which we may understand as little”, he was saying nothing which would strike his readers as outlandish. On the contrary, it would have been very hard for a contemporary to consistently deny that God’s omnipotence and freedom of will could endow matter with innate active principles.

It should be clear from all this that the use of occult qualities or unexplained active principles in matter in the mechanical philosophy was neither new with Newton nor confined to radical thinkers who were forced out of the natural philosophical mainstream because of their dangerous religious and political views. On the contrary, this kind of matter theory was always a major feature of the mechanical philosophy in England. Furthermore, it was so inextricably linked with other major traditions of both natural theology and philosophy; voluntarism, mitigated scepticism, experimentalism; that its importance for seventeenth century English natural philosophy can hardly be denied.

CONCLUSION

When Bernard le Bovier de Fontenelle inaugurated the Newton industry, with his Eloge of 1727, he wrote as a Cartesian. The cautious, halting and speculative
matter theories of earlier English mechanists can have made no impression on him, for he held Newton solely responsible for bringing back the occult quality of "attraction" which had been "banished from Physicks ... for ever" by Descartes. It seems that all subsequent Newton scholars have tacitly accepted the Fontenelle thesis. A more careful reading of Newton's immediate precursors from a less Newton-dominated, or a less Descartes-dominated, perspective gives the lie to this approach. In England the threatening political and religious upheavals militated against the easy acceptance of the strict mechanism associated with Descartes's name, and certainly Cartesianism was never propagated by educational establishments in England the way it was on the Continent. At the very least, English natural philosophers adopted the Gassendist view of matter with inherent automotive power, and many of them, as we have seen, took their speculations further. So, while Continental mechanists felt the need to object to Newton's use of occult qualities, no English mechanical philosopher did. Rather than follow Fontenelle, perhaps we should agree with John Keill who wrote in 1702 that

> Although now-a-days the mechanical philosophy is in great Repute, and in this Age has met with many who cuItivate it, yet in most of the writings of the Philosophers, there is scarce anything mechanical to be found besides the Name.

Indeed, the difficulties of providing a consistent account of all physical phenomena in strict mechanist terms, without recourse to active principles, taxed even the ingenuity of Descartes. As Westfall himself has pointed out

> In the discussion of many phenomena, of fire, for example, he [Descartes] summoned the subtle matter onto the stage, like a deus ex machina, to play the role of an active principle. Of course, Descartes always implied that its "agitation" resulted from mechanical necessity. In fact, he never analysed in detail how it was caused ... but rather dragged it in by brute force whenever a phenomenon appeared to reveal a level of activity not present before. In such passages his subtle matter can only be seen as a mechanist rendition of an Hermetic active principle.

If we ignore the historiographically passé use of the adjective "Hermetic" (he was writing in 1972) then we must surely agree with Westfall. However, while Westfall was correct in insisting that, nevertheless, Descartes "generally carried through the program of replacing the inherent activity of bodies with the passivity of matter dominated by mechanical necessity", he was surely mistaken in believing that "much the same can be said of Robert Boyle". As we have seen, Boyle and the other leading mechanical philosophers in England did not
merely modify strict mechanism, momentarily, to fudge over internal philosophical difficulties. Their very different version of the mechanical philosophy with its concept of matter imbued with occult active principles was developed in response to various complex and interrelated philosophical, religious and socio-political demands.

Scholarly efforts to trace the origins of Newton’s concept of force have so far concentrated on three areas. Perhaps the major effort has been to avoid metaphysical considerations and to see Newton’s conception as a development internal to the technicalities of the science of dynamics. But this internalist account has been supplemented by important studies of the influence of the Cambridge Platonists and of alchemy on Newton’s thought.\textsuperscript{115} We should now add another thread to this Newtonian fabric: the influence of English mechanical philosophy with its active principles and its occult qualities or rather, to adapt Newton’s phrase, its “manifest Qualities [whose] Causes only are occult”.\textsuperscript{116} Newton was able to draw from the work of his older contemporaries not only valuable hints about the inherent activity and powers of matter but also a ready-made methodological defence of these speculations in so far as their effects could be established and measured by experiment.\textsuperscript{117} Newton was able to alternate between, or combine, this phenomenological approach and the mathematical realism of thinkers like Kepler and Galileo, depending on what was most appropriate for the problem on hand.

If we persist in seeing Newton’s matter theory as a radical revision of the earlier mechanical philosophy, we must surely fail to do justice to the richness and complexity of the theories of his immediate precursors. Only by recognizing that Newton’s use of occult qualities and active principles is the culmination of seventeenth century English mechanical philosophy will we fully appreciate the significance of thinkers like Charleton, Power, Boyle, Petty and Hooke, to say nothing of lesser thinkers. Unless we can free ourselves from the biased interpretation of the mechanical philosophy of a thinker like Fontenelle, we might as well believe that God said, Let Newton be! – And all was overshadowed.

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1. I include Hobbes even though his mature system of natural philosophy, *De corpore* was not published until 1665 because he began to develop his system in the 1630s. The delayed publication of his system is in itself an indication of the difficulties which Hobbes had to surmount before he was satisfied. For a discussion of Hobbes's early efforts in natural philosophy see Jean Jacquot, “Sir Charles Cavendish and his learned friends”, *Annals of science*, viii (1952), 13-27, 175-91; and Frithiof Brandt, *Thomas Hobbes' mechanical conception of nature* (Copenhagen and London, 1928).

2. The quotation is from “Mr Petty’s letter in answer to Mr. More” (c. 1647) which is reprinted in Charles Webster, “Henry More and Descartes: Some new sources”, *The British journal for the history of science*, iv (1969), 359-77, p. 367.


4. Henry More, letter to Descartes (23 July 1649), and “Responsio ad fragmentum cartesii”, to Claude Clerselier (July-August 1655), both quoted from Alan Gabbey, “*Philosophia cartesiana triumphata: Henry More (1646-1671)*”, in T. M. Lennon, J. M. Nicholas and J. W. Davis (eds), *Problems of Cartesianism* (Kingston and Montreal, 1982), 171-250, 211 and 213; see also 192.


7. The suggestion that Newton’s interest in alchemy stemmed from his efforts to understand the active principles in matter was first made in J. E. McGuire, “Force, active principles and Newton’s invisible realm”, *Ambix*, xv (1968), 154-208, p. 166. Since then the notion has been taken up and elaborated in P. M. Rattansi, “Newton’s alchemical studies”, and R. S. Westfall, “Newton and the Hermetic tradition”, both in A. G. Debus (ed.), *Science, medicine and society in the Renaissance* (New York, 1972), 167-82 and 183-93 respectively; R. S. Westfall, “The role of alchemy in Newton’s career”, in M. L. Righini Bonelli and W. R. Shea (eds), *Reason, experiment and mysticism in the Scientific Revolution* (London,

8. Westfall, "Newton and the Hermetic tradition" (ref. 7), 185. Newtonian hagiography has been taken to new heights in Westfall's biography *Never at rest* (Cambridge, 1980), in which Westfall expresses his conviction that Newton was "wholly other" and that "with him there is no measure" (p. ix).

9. R. Descartes, *Principia philosophiae*, IV, 199: "Qu'il n'y a aucun phainomene en la nature qui ne soit compris en ce qui a esté expliqué en ce traité."

10. See above, refs 4 and 5.

11. For an excellent discussion of the latter problem together with other difficulties encountered by mechanical philosophers see Alan Gabbey, "The mechanical philosophy and its problems: Mechanical explanations, impenetrability, and perpetual motion", in J. C. Pitt (ed.), *Change and progress in modern science* (Dordrecht, 1985), 9-84. There is, unfortunately, no survey of critical responses to Descartes among natural philosophers and the material which springs most readily to mind is in Newton's work. Consider, for example, his *Questiones quaedam philosophicae*, now published as J. E. McGuire and Martin Tamny (eds), *Certain philosophical questions: Newton's Trinity notebook* (Cambridge, 1983); and *De gravitatione et aequipondio fluidorum*, translated and discussed in A. R. Hall and M. Boas Hall (eds), *Unpublished scientific papers of Isaac Newton* (Cambridge, 1962), 75-156. But see also the works by Glanvill cited above (ref. 3); and Robert Boyle, *An essay of ... languid and unheeded motions* (1685), chapter 5: "Of the propagable nature of motion"; which includes many examples of new motions and "New experiments about explosion" (1672) which can be found in *The works*, edited by Thomas Birch (6 vols, London, 1772), v, 12-18, and iii, 592-5, respectively.


14. His papers were known to Thomas Hobbes, John Wilkins, Ralph Bathurst and others. See Jacquot (refs 1 and 13) and [John Wilkins and Seth Ward,] *Vindiciae academiarium containing some brief animadversions upon Mr Webster's book, stiled, The examination of academies* (Oxford, 1654), 7 and 53.


18. J. B. van Helmont, *A ternary of paradoxes; the magnetical cure of wounds, the nativity of tartar in wine, the image of God in man*, translated, illustrated and amplified by Walter Charleton (London, 1650), sig. D4v, D2r, C2r.

19. Walter Charleton, *The darkness of atheism dispelled by the light of nature: A physico-theological treatise* (London, 1652), 47, 44, 46. See also the following section of this article. It should be
clear from what has been said here that the claim that Charleton’s work shows a dramatic change from an “overwhelming Renaissance-alchemical” position to a “blatantly atomistic” and “modern” approach is misconceived. See N. Rattner Gelbart, “The intellectual development of Walter Charleton”, Ambix, xviii (1971), 149-68, pp. 149-50. Gelbart was extending here a view proposed by P. M. Rattansi, “Paracelsus and the Puritan Revolution”, Ambix, xi (1963), 24-32. In fact, these views are casualties of the mistaken historiography I am seeking to correct. Providing we realize that it was perfectly possible to amalgamate atomist heuristic with Paracelsian/Helmontian and similarly alchemical and vitalistic world views (see ref. 17), then we can begin to read Charleton’s and other English mechanical philosophers’ works aright. For another critique of Gelbart’s views from a different perspective see Lotte Mulligan, “‘Reason’, ‘right reason’, and ‘revelation’ in mid-seventeenth-century England”, in Vickers (ed.), op. cit. (ref. 6), 375-401, pp. 379-82.

20. [Sir Matthew Hale,] Observations touching the principles of natural motions; and especially touching rarefaction and condensation: Together with a reply to certain remarks touching the gravitation of fluids (London, 1677), 3-5. Hale has yet to receive full scholarly attention. In the meantime see Sir Matthew Hale, The works, moral and religious... To which are prefixed his life and death by Bishop Burnet, D.D. and an appendix to the life, including the additional notes of Richard Baxter (London, 1805); and Edmund Heward, Matthew Hale (London, 1972).

21. Hale, Observations (ref. 20), 8, 9, 13, 10. On Newton’s drafts for the Queries see McGuire, “Force, active principles and Newton’s invisible realm” (ref. 7), 171. The quotation appears in Cambridge University Library, Add. MS 3970, f. 620r.

22. Henry Power, Experimental philosophy, in three books: Containing new experiments, microscopical, mercurial, magnetical. With some deductions and probable hypotheses, raised from them in avouchment and illustration of the now famous atomical hypothesis (London, 1664), sig. b4r, b3v, c2r, p. 61.


24. “Vegetation of metals” is the working title of Newton scholars for Burndy MS 16 with the incipit “Of Natures obvious laws & processes in vegetation”; the quotation is from f.5r. It is discussed in Rattansi’s and Westfall’s essays on Newton’s alchemy cited in ref. 7, and in B. J. T. Dobbs, “Newton manuscripts at the Smithsonian Institution”, Isis, lxviii (1977), 105-
7; and idem, op. cit. (ref. 7), 517-19. The quotation from the alchemical “Propositions” is taken from the latter, p. 515. For a full survey of Newton’s early alchemical writings see B. J. T. Dobbs, The foundations of Newton’s alchemy, or “The Hunting of the Greene Lyon” (Cambridge, 1975).


26. Thomas Willis, “A medico-philosophical discourse of Fermentation; or, Of the intestine motion of particles in every body”, in Dr Willis’ Practice of physick, being the whole works ..., translated by S. Pordage (London, 1684), 9. On Willis see Davis, op. cit. (ref. 25), 81-90; Frank, op. cit. (ref. 25), 165-9, 222-4, 232-7, 248-50; and T. S. Hall, Ideas of life and matter (2 vols, Chicago, 1969), i, 312-25. On Mayow see Frank, op. cit. (ref. 25), 224-32, 258-74; and Hall, i, 326-36. On Lower see Frank, 188-205, 208-20; and Hall, i, 337-42.

27. Newton, op. cit. (ref. 12), 399-400, see also 401. Cf. McGuire, “Force, active principles and Newton’s invisible realm” (ref. 7), 171; and Dobbs, op. cit. (ref. 7), 515-19.


30. Boyle, Works (ref. 11), iv, 85-104, p. 90. Hall, op. cit. (ref. 26), i, 291-2, discusses the Paracelsian nature of these and similar ideas in Boyle’s writings.

31. Boyle, Works (ref. 11), iv, 79.

32. Boyle, Works (ref. 11), iii, 306-16, p. 306; 316-25, p. 316. The concept of ‘powers’ or ‘faculties’ is a highly complex philosophical notion and should be treated with some care. For philosophical analyses of the concept in both Boyle and Locke, see F. J. O’Toole, “Qualities and powers in the corpuscular philosophy of Robert Boyle”, Journal of the history of philosophy, xxii (1974), 295-315; Peter Alexander, Ideas, qualities and corpuscles: Locke and Boyle on the external world (Cambridge, 1985), especially pp. 150-67; and R. M. Mattern, “Locke on active power and the obscure idea of active power from bodies”, Studies in the history and philosophy of science, xi (1980), 39-77. O’Toole argues that for Boyle powers cannot simply be reduced to the primary (mechanical) qualities but are a function of those qualities (pp. 310-11); Alexander, similarly, argues that powers may be intrinsic properties of things but only by virtue of being entailed by the primary qualities (p. 160). Clearly they both feel that powers can be explained, ultimately, in strictly mechanist terms. I differ from them in this. I feel that they are further victims of the prevailing historiography. Alexander, for example, insists that Boyle was “suspicious” of...
“occult qualities” and Newtonian forces. As we have seen, this is not necessarily so and we will try to explain why some occult qualities were acceptable to the mechanical philosophers in the third section of this article. Keith Hutchison has already pointed out the tendency of historians (and philosophers) to misread the evidence on this matter and has argued that seventeenth century natural philosophers only rejected certain kinds of occult quality; see his importantly revisionist paper: Keith Hutchison, “What happened to occult qualities in the Scientific Revolution?”*, Isis*, lxxiii (1982), 233-253, pp. 235, 252. Of course, given his probabilistic outlook (see ref. 29 and L. Laudan, “The clock metaphor and probabilism: The impact of Descartes on English methodological thought, 1650-65”, *Annals of science*, xxii (1966), 73-104), Boyle no doubt thought it possible that one day all powers of bodies would be explained in strict mechanist terms but, by the same token, he could also entertain the possibility that there may be other “ways of working”. Such notions were perfectly acceptable providing they could be investigated experimentally (see third section of this article). For an excellent defence of these ideas by a philosopher of science see R. Harré, “Powers”, *British journal for the philosophy of science*, xxi (1970), 81-101.

34. Boyle, *Languid and unheeded motions*, *Works* (ref. 11), v, 14. For further examples see ch. 5 of this essay, “Of the propagable nature of motion”. See also Hall, *op. cit.* (ref. 26), i, 287.
36. Boyle, *Excellency and grounds*, *Works* (ref. 11), iv, 72; *General history of the air*, *Works*, v, 615. Cohen (ed.), *op. cit.* (ref. 28), 181, 179. See also Robert Boyle, “An explication of rarefaction”, *Works*, i, 179-80; *New experiments physico-mechanical touching the spring of the air*, *Works*, i, 12; *The history of fluidity and firmness*, *Works*, i, 387; *Of absolute rest in bodies: An essay of the intestine motions of the particles of quiescent solids, where the absolute rest of bodies is called in question*, *Works*, i, 443-57; “An historical account of a strangely self-moving liquor”, *Works*, v, 71-73. And Hall and Hall (eds), *op. cit.* (ref. 11), 224.
37. Robert Hooke, *Micrographia: Or some physiological descriptions of minute bodies made by magnifying glasses, with observations and inquiries thereupon* (London, 1665), 16.
39. Henry More, *The second lash of Alazonomastix laid on in mercie upon that stubborn youth Eugenius Philalethes: Or a sober reply to a very uncivill answer to certain observations upon Anthroposophia Themagica and Anima magica abscondita* (London, 1651), 67. Occasionally, of course, it is possible to find Hooke attempting to give a strict mechanical account of such vibrations. Cf. *De potentia restitutiva*: “This Vibrative motion I do not suppose inherent or inseparable from the Particles of body, but communicated by Impulses given from other bodies in the Universe”, in R. T. Gunther (ed.), *Early science in Oxford* (14 vols, Oxford, 1921-45), viii, 340. Presumably Hooke’s inconsistency stems from the specific occasion of each utterance. An awareness of the kind of criticism that might be levelled at him from a Cartesian or even a theologian like More might stimulate a greater confidence in strict mechanism than on other occasions.
43. These speculations appear in Query 21 of Newton’s *Opticks* and in his letter to Robert Boyle of February 1679, which is reprinted in Cohen (ed.), *op. cit.* (ref. 28), 250-3. See also Newton’s *De aere et aethere* in Hall and Hall (eds), *op. cit.* (ref. 11), 214-28.
46. Walter Charleton, *Natural history of nutrition, life and voluntary motion: Containing all the new discoveries of anatomist’s, and most probable opinions of physicians, concerning the oeconomie of human nature...* (London, 1659), 13; Willis, *op. cit.* (ref. 26), 1.
47. Boyle, “Of the admirably differing extension of the same quantity of air rarefied and compressed”, *Works* (ref. 11), iii. 509. See also, *Works*, i, 11-12, 19-20, 178-82; ii, 503-4; iii, 278-9; v, 28.
49. Sir Kenelm Digby, *Two treatises. In the one of which the nature of bodies; in the other the nature of mans soule is looked into: In way of discovery of the immortality of reasonable souls* (Paris, 1644), 21.
50. Hall and Hall (eds), *op. cit.* (ref. 11), 317 (Latin, p. 314); see also 306 (303), 341 (328). Newton had read Digby’s *Two treatises* early in his career. See Westfall, *op. cit.* (ref. 15), 172; J. E. McGuire, “The origin of Newton’s doctrine of essential qualities”, *Centaurus*, xii (1968), 233-60, pp. 244-6. Westfall has not made this connection between Newton’s net-like matter and anti-atomist arguments but has linked it instead to Newton’s searches for the alchemical ‘net’. See Westfall, *op. cit.* (ref. 8), 389, 508-9; and *idem*, “Alchemy in Newton’s career” (ref. 7), 209-10. See also Dobbs, *Foundations of Newton’s alchemy* (ref. 24), 161-3.
51. Hall and Hall (eds), *op. cit.* (ref. 11), 223, (Latin, p. 216).
52. Westfall, *op. cit.* (ref. 6), 317; and *idem*, *op. cit.* (ref. 28), 377.
53. [Sir Matthew Hale,] *Difficiles nugae: Or, observations touching the Torricellian experiment, and the various solutions of the same, especially touching the weight and elasticity of the air. The second edition with some occasional additions* (London, 1675), 181. Sir Kenelm Digby calculated that the proportion of empty space to matter in air must be at least as disparate as 7,600 to 1. This was based on the assumption that gold was completely free of void interstices and was 7,600 times denser than air. Digby, *op. cit.* (ref. 49), 20-21. Digby drew his figures from Marinus Ghetaldus, *Promotus archimedes seu variis corporum generibus gravitate et magnitudine comparatus* (Rome, 1603), 32.
54. Hale, *op. cit.* (ref. 53), 183.
55. Charleton, *op. cit.* (ref. 19), 47.
57. Petty, *op. cit.* (ref. 56), 125-6.


65. [Joseph Glanvill and George Rust,] *Two choice and useful treatises: the one Lux orientalis or an enquiry into the opinion of the eastern sages concerning the preexistence of souls... The other a discourse of truth... with annotations on them both* [by Henry More] (London, 1682), 10, and “Annotations upon Lux orientalis” (separately paginated), 9.

66. Boyle, *A free inquiry into the vulgarly received notion of Nature, Works* (ref. 11), v, 158-254, pp. 165, 162; see also *A disquisition about the final causes of natural things* (1688), *Works*, v, 399.


68. Charleton, *op. cit.* (ref. 19), 46; [Sir Matthew Hale,] *An essay touching on the gravitation, or non-gravitation of fluid bodies, and the reasons thereof: The second edition with some occasional additions* (London, 1675), 44.

69. Westfall, *op. cit.* (ref. 8), 509-10. The fact that Newton reverted to naturalistic explanations can be seen in the Queries to the *Opticks* but it is also well brought out in David Kubrin, “Newton and the cyclical cosmos: Providence and the mechanical philosophy”, *Journal of the history of ideas*, xxviii (1967), 325-46. The evident reluctance of English natural philosophers to involve God directly in their natural philosophies, as Westfall has perceptively noted, “prepared the ground for the deists of the Enlightenment”, Westfall, *op. cit.* (ref. 29), 219. Similarly, in a recent essay Westfall has argued that Newton was a
crypto-deist in spite of himself: *idem*, "Newton's theological manuscripts", in Bechler (ed.), *op. cit.* (ref. 44), 129-43, p. 140.


73. There is a vast body of seventeenth century literature devoted to the refutation of atheism as though it is a serious presence in contemporary mores. Much of this literature attacks the new philosophy as a major source of encouragement for atheists. This topic is yet to receive definitive treatment but in the meantime see Westfall, *op. cit.* (ref. 29); Michael Hunter, *Science and society in Restoration England* (Cambridge, 1981), 162-87; and John Redwood, *Reason, ridicule and religion: The age of enlightenment in England 1660-1750* (London, 1976).


75. *Ibid.*, 30, 31; see also 36.

76. I have argued this more fully in Henry, *op. cit.* (ref. 23).

77. Perceptive or appetitive matter was directly linked to the automotive power of matter by Francis Glisson, *op. cit.* (ref. 23), and was an explicit feature of many biomedical theories, see immediately below. On Boyle's rejection of these ideas see ref. 107 below. It should be noted that Bentley's second Boyle lecture was entitled "Matter and motion cannot think: Or a confutation of atheism from the faculties of the soul". The most convenient study of Newton's belief in active matter is McMullin, *op. cit.* (ref. 5).

78. See ref. 23 above.


80. This is essentially the thesis of J. R. Jacob and M. C. Jacob, "The Anglican origins of modern science: The metaphysical foundations of the Whig constitution", *Ists*, lxxi (1980), 251-67; and is implicit in much of their other work. See for example, J. R. Jacob, *Henry Stubbe, radical Protestantism and the early Enlightenment* (Cambridge, 1983); and M. C. Jacob, *The Newtonians and the English Revolution, 1689-1720* (Hassocks, 1976). It should be apparent from what has been said here that this kind of affiliation of matter theory to ideology will
not do. There are broadly similar claims made by a number of other historians. Carolyn Merchant, *The death of nature: Women, ecology and the Scientific Revolution* (San Francisco, 1980), for example, wishes to argue that the magical world view, occultism and a vitalistic belief in active matter can be associated, historically, with naturalistic, ecological and even 'feminine' ideals, while the mechanical philosophy insisted upon dead, passive matter and was exploitive, aggressive, antithetical to the concept of nature and anti-feminist. For similar claims see David Kubrin, "Newton’s inside out: Magic, class struggle, and the rise of mechanism in the West", in Harry Woolf (ed.), *The analytic spirit: Essays in the history of science in honor of Henry Guerlac* (Ithaca, 1981), 96-121; and Brian Easlea, *Witch-hunting, magic and the New Philosophy: An introduction to debates of the Scientific Revolution, 1450-1750* (Hassocks, 1980). I believe that each of these writers and their theses have fallen victim to the prevailing mistaken historiography of pre-Newtonian matter theory (and like the victims of the vampire they then serve to propagate the same erroneous historiography).

81. Westfall, *op. cit.* (ref. 6), 324. Newton, *op. cit.* (ref. 12), 401. In using the word 'phenomenological' I mean it only in its literal sense: the study of phenomena as opposed to the study of being. I do not intend it to convey all the philosophical baggage attached to the word by Husserl and his followers. It is important to note also that our natural philosophers were not phenomenalists: they did not believe that only phenomena are real. They believed in a reality underlying phenomena, knowledge of which could frequently be inferred (at least within certain limits laid down by their mitigated scepticism — see ref. 99 below) from experimental investigation.

82. I. B. Cohen, "The *Principia*, universal gravitation, and the 'Newtonian style', in relation to the Newtonian Revolution in science", in Bechler (ed.), *op. cit.* (ref. 44), 21-108; and *idem*, *The Newtonian Revolution, with illustrations of the transformation of scientific ideas* (Cambridge, 1980). The erudition and historical acumen of Professor Cohen together with the complexity and subtlety of his case go a long way to making these much more than hagiography. Nevertheless, I can’t help feeling they would be suitable candidates for analysis along the lines suggested in John A. Schuster, "Methodologies as mythic structures: A preface to the future historiography of method", *Metascience*, i (1984), 15-36.

83. Cohen, "The *Principia* ... and the ‘Newtonian style’ " (ref. 82), 56, and see also 62; Isaac Newton, *Mathematical principles of natural philosophy and his system of the world*, translated by Andrew Motte in 1729 revised by Florian Cajori (Berkeley, 1960), 546-7. For further examples of Newton’s insistence that “we know the properties of things from phenomena”, and related ideas (including the interesting remark: “I avoid hypotheses whether mechanical or of occult qualities”) see Hall and Hall (eds), *op. cit.* (ref. 11), 360-1 (Latin, 356), which is a draft for the General Scholium.

84. Glanvill, *Vanity of dogmatizing* (ref. 3), 210. Of course, the explanatory lacunae also provide an ever-present guarantee that the mechanical philosophy cannot be commandeered for atheist purposes. My claim here, that the ascription of occult qualities in matter as an explanation of a given phenomenon will lead to further experimental investigation of the matter and the phenomenon, has recently been described as “what scientists actually do” in Harré, *op. cit.* (ref. 32), 90.


86. Glanvill, *Vanity of dogmatizing* (ref. 3), 202-4, p. 204.


88. Boyle, “Hydrostatical discourse”, *Works* (ref. 11), iii, 601; cf. 627.
94. Hutchison, *op. cit.* (ref. 32). In making his case Hutchison also shows how historians have misinterpreted the many attacks on occult qualities which were prevalent at this time. George MacDonald Ross, “Occultism and philosophy in the seventeenth century”, in Holland (ed.), *op. cit.* (ref. 79), 95-115, makes a broadly similar point when he says that “the new philosophers following the ‘way of ideas’ were even more dependent than the occultists on hidden or occult entities” (p. 102).
95. I quote from the draft Newton sent to Cotes on 2 March 1712/13 which now forms part of the Newton-Cotes Correspondence (Trinity College Library, R.16.38). I have used the translations provided in I. B. Cohen, *Introduction to Newton’s ‘Principia’* (Cambridge, 1971), 241. Cohen discusses the various drafts of the scholium, pp. 240-5.
96. Letter from Leibniz to Conti, November/December 1715; draft of letter from Newton to Conti, 26 February 1715/16. These are quoted from and fully discussed in A. Koyré and I. B. Cohen, “Newton and the Leibniz-Clarke correspondence, with notes on Newton, Conti & Des Maizeaux”, *Archives internationales d’histoire des sciences*, xv (1962), 63-126, pp. 70 and 74; see also pp. 110 and 113 for drafts which make similar comments.
98. I have discussed Boyle, Petty, Glanvill and Hooke above; on Charleton see Hutchison, *op. cit.* (ref. 32), 245, where we are told that “Charleton is attacking not occult qualities but the Aristotelians”.


103. Consider Boyle, *Usefulness of experimental natural philosophy*, *Works* (ref. 11), ii, 45; or *Certain physiological essays*, *Works*, i, 355-6; and the secondary sources cited in ref. 29. The ideological uses of ‘mitigated scepticism’ were, of course, first chronicled in R. H. Popkin’s *A history of scepticism* (1960), now revised as *A history of scepticism from Erasmus to Spinoza* (Berkeley, 1979); but see also Barbara J. Shapiro, *Probability and certainty in seventeenth-century England* (Princeton, 1983). I have given indications of the response to the dogmatic use of the mechanical philosophy to promote counter-reforming Catholic theology in John Henry, “Atomism and eschatology: Catholicism and natural philosophy in the Interregnum”, *The British journal for the history of science*, xv (1982), 211-39, especially pp. 237-9. For the response to ‘enthusiastic’ natural philosophy see P. M. Rattansi, *op. cit.* (ref. 19). Although I am critical of Rattansi’s paper in ref. 19 above, I fully accept his claim that various Paracelsian/Helmontian world views were associated by contemporaries with subversive ‘enthusiasm’ in religion. My point is merely that he is mistaken in seeing this as a factor leading to the rejection of concepts of active matter. Owen Hannaway in his study of an earlier debate about Paracelsian philosophy has quite clearly shown that it is possible for a thinker to reject Paracelsian ‘enthusiasm’ while still accepting Paracelsian active principles in matter; Hannaway, *op. cit.* (ref. 23), 84-85, 90-91, 99 and *passim*.


105. On the importance of this tradition to the development of science see the works by McGuire
and Oakley cited in ref. 67; Hooykaas, op. cit. (ref. 63); Margaret J. Osler, “Descartes and Charleton on Nature and God”, Journal of the history of ideas, xi (1979), 445-56; Eugene M. Klaaren, Religious origins of modern science: Belief in creation in seventeenth-century thought (Grand Rapids, 1977), 29-52. Oakley, “Christian theology and the Newtonian science” (ref. 67), 442. Unfortunately there are exceptions to this rule. Descartes and Hobbes both managed to combine voluntarism with rationalism. This needs to be explained. R. Hooykaas, op. cit. (ref. 63) noted merely that Descartes’s combination of voluntarism and rationalism was “strange” (p. 41) and “paradoxical” (p. 42) but he made no attempt to account for it. Margaret Osler argues that Descartes is a modified necessitarian (necessitarianism being the theological position opposed to voluntarism) but I find this unconvincing. As far as I know there is no study of Hobbes’s voluntarism but see J. Barnouw, “The separation of reason and faith in Bacon and Hobbes and Leibniz’s Theodicy”, Journal of the history of ideas, xlii (1981), 607-28, pp. 616-19. These are serious lacunae in our understanding of seventeenth century natural philosophy. Nevertheless, irrespective of Descartes’s and Hobbes’s attitudes, we can safely say that the majority of voluntarist mechanical philosophers professed themselves to be empiricist, and argued that their view of God and his relationship to the world was only compatible with empiricism.

106. Locke, op. cit. (ref. 79), IV, iii, 6.

107. Glisson, De natura substantiae energetica (ref. 23), sig. A5r. Let two examples of Boyle’s rejection of ‘sense and appetite’ in matter suffice: High veneration to God (1685), Works (ref. 11), v, 141; and Notion of Nature, Works, v, 222. Ralph Cudworth, The true intellectual system of the universe (London, 1678), 105; Henry More, Opera omnia (2 vols, London, 1679), i, 604-11. More’s and Cudworth’s attacks on Glisson are discussed in Henry, op. cit. (ref. 23). More’s necessitarianism and his opposition to Boyle’s voluntarism are discussed in Henry, op. cit. (ref. 70). On Cudworth’s necessitarianism see Oakley, “Christian theology and the Newtonian science” (ref. 67), 441; Richard Baxter, Of the immortality of Mans Soule, and the nature of it, and other spirits ... (London, 1682), 28-29.


109. Cohen (ed.), op. cit. (ref. 28), 185. I have yet to come across a natural philosopher in England who was not a voluntarist.


111. See, for example, E. G. Ruestow, Physics at seventeenth and eighteenth century Leiden (The Hague, 1973); or compare L. W. B. Brockliss, “Aristotle, Descartes and the New Science: Natural philosophy at the University of Paris, 1600-1740”, Annals of science, xxxviii (1981), 33-69; with R. G. Frank Jr, “Science, medicine and the universities of early modern England: Background and sources”, History of science, xi (1973), 194-211, 239-69. Consider also David Hume’s puzzlement in 1748: “I must confess, that there is something in the fate of opinions a little extraordinary. Des Cartes insinuated that doctrine of the universal and sole efficacy of the Deity without insisting on it. Malebranche and other Cartesian made it the foundation of all their philosophy. It had, however, no authority in England. Locke, Clarke and Cudworth, never so much as take notice of it, but suppose all along that matter has a real, though subordinate and derived power. By what means has it become so prevalent among our modern metaphysicians?” Hume, op. cit. (ref. 3), VIII, i, 57, in the footnote.

112. John Keill, Introductio ad veram physicam: Seu lectiones physicae (Oxford, 1702), sig. b1r. I
have taken the translation from the fourth edition: *An introduction to natural philosophy* (London, 1745), iii.

113. Westfall, “Newton and the Hermetic tradition” (ref. 7), 187. Hermeticism is currently out of vogue largely as a result of Westman and McGuire, *op. cit.* (ref. 7); and C. B. Schmitt, “Reappraisals in Renaissance science”, *History of science*, xvi (1978), 200-14. For further surveys which suggest that Descartes was forced to smuggle activity into his system see Prendergast, *op. cit.* (ref. 5); and Hatfield, *op. cit.* (ref. 5).

114. Westfall, “Newton and the Hermetic tradition” (ref. 7), 187.

115. For the latter see refs 6 and 7 above. For the former consider René Dugas, *Mechanics in the seventeenth century* (Paris, 1958); John W. Herivel, *The background to Newton’s “Principia”* (Oxford, 1965); developments in dynamics are also the major focus of Westfall, *op. cit.* (ref. 28); and Gabbey, *op. cit.* (ref. 5), and Cohen, *op. cit.* (ref. 82). See also D. T. Whiteside, “The mathematical principles underlying Newton’s *Principia mathematica*. *Journal for the history of astronomy*, i (1970), 116-38; and *idem*, “Newton the mathematician”, in Bechler (ed.), *op. cit.* (ref. 44), 109-27.


117. Once again the reader is referred to the spirited promotion of just this methodological approach in Harré, *op. cit.* (ref. 32).
MEDICINE AND PNEUMATOLOGY: HENRY MORE, RICHARD BAXTER, AND FRANCIS GLISSON'S TREATISE ON THE ENERGETIC NATURE OF SUBSTANCE

The nature of the soul and its relationship to the body has always proved problematical for Christian philosophy. The source of the difficulty can be traced back to the efforts of the early Fathers to reconcile the essentially pagan concept of an immaterial and immortal soul with apostolic teachings about the after-life in which all the emphasis is placed upon the resurrection of the body. The tensions between these two traditions inevitably became strained during the sixteenth century when Protestant reformers insisted on a closer adherence to Scripture. Furthermore, even when leaving the problems of Scriptural hermeneutics aside, the dualistic approach to the question, in which soul (or spirit) and body are held to be categorically different in essence, had to overcome a number of intractable philosophical problems. So, it was not simply coincidence that when the new mechanical philosophy began to be formulated in a systematic way in the seventeenth century, it was couched in vigorously dualistic terms. In fact, three of the earliest fully elaborated systems of mechanical philosophy, those of Descartes, Digby, and Charleton, were explicitly intended to provide a philosophical prop for dualist theology. Furthermore, it was because of its usefulness in promoting dualism that Cartesianism was first popularized in England not by a natural philosopher but by the Cambridge Platonist and theologian, Henry More.


In spite of this powerful support, however, there were still those who regarded the dichotomy between soul and body, so essential to dualism, as fundamentally inimical to any satisfactory explanation of psychosomatic interaction. Accordingly, monistic solutions to this problem also attracted some formidable advocates. Certainly, the greatest of these were the materialist Thomas Hobbes, the hylotheist Baruch de Spinoza, and the vitalist Gottfried Wilhelm Leibniz. But monistic pneumatology also found allies in a well-established tradition of medical thought. In a series of articles, D. P. Walker has shown the links between medical concepts of “spirit” and materialistic views of the human soul, while Walter Pagel has underlined the monistic pneumatology of two of the leading medical theorists in seventeenth-century England, William Harvey and Francis Glisson.3

The crucial nature of the ensuing debate between dualists and monists is revealed by the reaction of that champion of Cartesian dualism, Henry More. As is well known, More lost no time in publishing a detailed attack on Hobbes’s De corpore (1655) in his The immortality of the soul (1659), and in the 1670s, he turned his attention to the new threats, Cartesian atheism and Spinozism.4 However, what has hardly been noticed before is that More also wrote a refutation of Francis Glisson’s Tractatus de natura substantiae energetica (1672).5

Glisson’s Treatise deserves recognition as one of the most original systems of philosophy to appear in the second half of the seventeenth century and as one of the most profound attempts to develop a monistic solution to the mind-body problem. One reason for the failure of intellectual historians to recognize its importance stems from the commonly held belief that it had absolutely no influence upon Glisson’s contemporaries. The aim of this paper is to make a start towards correcting this erroneous view. Glisson’s philosophy, as expressed in the Treatise, is rich, complex and


5 Francis Glisson, Tractatus de natura substantiae energetica, seu de viis naturae, eiusmod tribus primum facultatibus, I. perceptiva naturalibus, II. appetitiva naturalibus, III. motiva naturalibus & c., London, E. Flesher for H. Brome and N. Hooke, 1672.
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subtle, and manages to be innovatory while drawing heavily upon scholastic traditions and Renaissance philosophical eclecticism. A full exposition of his philosophy has yet to be attempted and is not within the scope of this essay. Here, we will look at Glisson only as he appeared to Henry More and Richard Baxter, two of the leading contemporary English theologians, who explicitly dealt with his theories. While considering the background to and the reasons for their interest in Glisson it will become clear that medical theories frequently had a profound influence on philosophy and theology in the early modern period. Before embarking on this, however, it is important to recognize the intimate connexion between Glisson's new system of natural philosophy and his medical concerns, and to this we will turn first.

**Francis Glisson's Medical Philosophy**

Glisson's output in print is not extensive, and there is a clear continuity of interests and themes running through his published works. The continuity is most clear between the *Anatomia hepatis* of 1654 and his next medical treatise, the *Tractatus de ventriculo et intestinis* of 1677. However, as Temkin and Pagel have pointed out, there are a number of notions employed by Glisson in his early efforts to understand the nature of rickets which foreshadow his later ideas. Temkin has traced Glisson's concept of irritability, most famously expounded in *De ventriculo*, to his description of the pulse in *De rachitide*: as the arteries thrust blood into the parts of the body there is a certain resistance which “provokes” or “irritates” the heart and arteries into increasing the pressure. A strong pulse will not be found, therefore, where resistance is low, as in the rachitic. Pagel, on the other hand, has pointed to Glisson's early use of the concept of “tension” or “tone” in the nerves to account for both sense and locomotion. By brooding on the notion of irritation and the role of the nerves in this process Glisson

was eventually led to his mature concept of irritability, in which all fibres in the body
are said to be “irritable” even without the mediation of nerves.7

Glisson’s first prolonged efforts, in *Anatomia hepatis*, to define the nature of
“irritability” as a biological phenomenon presupposed that nervous sensibility in the
irritated part was a *sine qua non*. “All irritation”, he wrote, “indicates the existence of
perception”, and that, in turn, indicates the presence of nerves.8 Glisson considered
different kinds of “irritation” which could activate particular nerves and so lead to
bodily changes or movements. The nerves responded to three kinds of activation:
perception or sensation, appetite, and muscular movement. This, as Temkin has
shown, was entirely in accord with Galen’s teachings about the threefold purpose of
the nerves: sensibility in the organs of perception, initiation of movement in the organs
of locomotion, and in all other organs “the recognition of distressing things”
(equivalent to Glisson’s concept of appetite).9

Glisson developed these ideas in anatomical lectures delivered to the Royal College
of Physicians shortly after the publication of his book on the liver. In his lecture on the
brain, Glisson averred that its actions and uses consisted “in the exercise of its noble
faculties, perception, appetite and motion”.10 He seems to have had no difficulty in
locating the faculties of perception and appetite in the brain and he felt confident,
therefore, in locating the motive faculty in the same organ:

> For if it be the braine which perceives, it must be the braine also which desires & the same which
> prosecutes that desire. For the desire were in vaine, if the braine had noe power to move toward a
> prosecution of the same, & there would be noe animall motion, if the braine had no power to
> command it.11

However, although Glisson was convinced that the motive faculty is located in the
brain, he was all too aware of the difficulty of explaining the operation of this faculty:

> the manner how this power or faculty is put in execution, is soe obscure & hard to be conceived,
> that the minde reflecting upon it selfe, cannot clearly trace its owne footstepps. It is hard indeed to
> follow the track of the ideae’s [sic] from the outward senses to the braine, but much more difficult
> to trace the edicts of the braine back againe to the outward organs of motion, yet this in nature
> must be done.12

Abandoning all pretence to “a clear account of this”, Glisson merely offered “some
propositions about it”. The first of these is that the brain could only excite the nerves to
initiate motion by means of its own motion:

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7 F. Glisson, *Anatomia hepatis*, cui præemittuntur quaedam ad rem anatomicam universe spectantia et, ad
calcem operis, subjiciuntur nonnulla de lymphae ductibus nuper repertis, London, O. Pullein, 1654; idem.
Tractatus de ventriculo et intestinis, cui præemittitur allius de paribus continentibus in genere & in specie de is
have used the English Translation of the latter, *A treatise of the rickets: being a disease common to children*,
London, Peter Cole, 1651, see ch. 10, especially pp. 86–88, discussed in Temkin, op. cit., note 6 above, p. 294,
8 Glisson, *Anatomia hepatis*, ch. 44, p. 397, and ch. 30, pp. 262–266. See Temkin, op. cit., note 6 above,
9 Temkin, op. cit., note 6 above, p. 302.
10 British Library, Sloane MS 3306, f.157.
12 Ibid., f.163.
For it is not conceivable, how the nerves should be excited, or they excite the muscles to work according to the mind of the brain, if they were by no act of the brain to give a signal to the nerves & outward organs; that act must be some kind of motion in the brain itself. For the brain cannot move the nerves, either by its perception or appetite, because those are both immanent actions & cannot reach any thing out their owne subject. For it is not conceivable, how the nerves should be excited, or they excite the muscles to work according to the mind of the brain, if they were by no act of the brain to give a signal to the nerves & outward organs; that act must be some kind of motion in the brain itself. For the brain cannot move the nerves, either by its perception or appetite, because those are both immanent actions & cannot reach any thing out their owne subject.

The second proposition was that the brain's "imperiall kinde of mandate" to the nerves "proceedes noe further, then to the grosse commande of such or such an action to be done".

For a beast which also may make such an animal motion, knows not soe much, as that he hath a braine or nerves or muscles. Wherefore, the braine cannot give a particular command to every nerve or muscle, when it excites a motion. But it is content with the giving such a general excitation, that such a motion may be made. And upon such excitation, the nerves excite the muscles proper, whereby the motion is affected.

The role of the brain in initiating the movements of bodily parts now begins to look precarious, and its supremacy is hardly supported by Glisson's third and final proposition. Here, Glisson unwittingly attributed to the nerves a mind of their own, as it were, which enabled them to carry out "such a grosse command as that last before mentioned". So, "the nerves serving for every motion, may be sufficiently excited" while "other nerves, upon that excitation will not at all be stirred".

because those nerves only, which are proper to the action required, have learned by custome & long practice, that they are to move upon such a signal given, and the other nerves have in like manner been accustomed to sit still upon the same signal. Wherefore, I conclude, that the nerves learn to execute the dictates of the brain, upon the signal given, by custome and often experience.

Only a few folios earlier, Glisson had described how memory and learning were special attributes of the perceptive faculty, that "immanent action" which "cannot reach any thing with out [its] owne subject". Small wonder, then, that Glisson's lecture on the brain and its three noble faculties breaks off abruptly at this point.

However, Glisson was not the only one to be confused about these matters. Even his mentor, the great William Harvey, had expressed contradictory ideas about the seat of perception in his De generatione animalium (1651). One moment Harvey implied that irritability depended on the mediation of the brain:

that which is plainly devoid of all sensation does not seem to be able to be provoked in any way or to be excited to move or initiate any actions. And we have no other sure sign by which we can distinguish an animate and sentient creature from one that is dead and senseless except by its movement which is provoked by some offensive object and which follows immediately upon the experience of this sensation and so proves the existence of sensation. But it is reasonable to discuss this matter further when we treat of the actions and use of the brain.

13 Ibid.
14 Ibid., f.165.
15 Ibid., f.165 6.
16 Ibid., f.163.
And yet, only a few paragraphs earlier, Harvey wrote about motions independent of the brain and other sensory organs:

Those motions and actions which the physicians call natural because they go on whether we will or no, and which we can neither moderate, accelerate, retard nor inhibit at our pleasure and are therefore independent of the brain, yet they are not performed without any sensation at all. . . . For whatsoever it is that by the diversity of its own movements strives against these things which provoke and molest it, must needs be endowed with sensation.  

Significantly, one of Harvey's examples of organs exhibiting innate sensitivity referred to the stomach and guts:

The stomach and guts attacked by bad humours, often stir up nausea, and belching, rumbling, vomiting and flux of the bowels, and it is not in our power to arrest these movements or to instigate them, and so I do not know of any sense depending on the brain which should excite those parts to actions of this kind.

When Glisson decided to follow up his research into the anatomy and function of the liver, he chose as his subject the stomach and guts. It was during the course of this work that he developed his concepts of natural perceptions, appetites, and natural motility in all the fibres of the body even where no nerves were present. In developing these ideas, Glisson was able to draw not only upon various hints in Harvey, Galen, and Aristotle but also, as Pagel has shown, upon certain ideas found in the works of Joan Baptista van Helmont. In particular, the concept of nerves "learning" from experience whether to respond or not to a "grosse command" of the brain, which seemed so anomalous in his lecture on the brain to the Royal College, gave place to a general claim that all fibre in the body is capable of "learning" and "knowing" by virtue of its archeus or natural perception.

By his own account, Glisson had completed his work on the stomach and intestines by 1662 but he held it back for fifteen years before publishing it. The reason he gave for this leaves us in no doubt as to the importance he placed upon his Treatise on the energetic nature of substance for a full understanding of his anatomical work. His first draft of De ventriculo "presupposed in many places (although also proving in many places) a general Natural Perception" which had not been written about anywhere. Consequently, "it seemed right", Glisson wrote, that the draft "should be postponed until I could produce and bring into the light another Treatise, forerunner to this, on the Life of Nature". According to a manuscript fragment, Glisson believed that the delay would amount to no more than two years, but clearly he was over-optimistic. "After the triall of a year or two I founde the worke so difficult", he said, "that it seemed to involve the whole body of natural physiology." In the event, his
Medicine and pneumatology

Tractatus . . . de vita naturae appeared in 1672, five years before the final version of De ventriculo. It is here that Glisson developed and expounded the notion that substance or matter itself has an “energetic nature” and a “life” which is primarily exemplified in those three “noble faculties” he once reserved for the brain: the perceptive, appetitive, and motive faculties.

Glisson clearly agreed with Harvey’s sentiments expressed in De generatione, that the only way to distinguish between “an animate and sentient creature” and “one that is dead and senseless” was in terms of perception and the ability to move in accordance with those perceptions. The point of Glisson’s De vita naturae, however, was simply to show that there was no such thing as “dead and senseless” matter. All matter, organic and inorganic alike, was endowed with life, Glisson insisted, and that life was defined in terms of an intrinsic motility which could be activated by inherent perceptivity and appetite (or aversion) within the matter itself. The difference, for Glisson, between what was usually considered to be non-living and living matter was simply one of organization. Provided matter was organized in a suitable way, the natural perception of matter could be “reduplicated” so that it perceived its own perception—giving rise to the sensitive nature of animals—and the vita naturae could be “duplicated” or “triplicated” to produce what we recognize as vegetable or animal life. The death of a plant or animal occurs upon the dissolution of this double or triple alliance.

Glisson’s views on the nature of plant and animal life led naturally in his Treatise to a categorical rejection of the concept of a separate “substantial soul” in animals. This in itself, however, was not a radical departure from contemporary medical thinking: Cartesians too denied the existence of an animal soul, and Gassendists, like Walter Charleton and Thomas Willis, regarded it as a subtle material principle which dissipated on the death of the animal. Furthermore, Glisson was careful to point out that man was endowed with an immaterial rational soul which, being preternatural, fell outside the purview of his natural philosophy. Nevertheless, in view of the vigorous monistic approach to the concept of life expressed in De vita naturae, it is easy to imagine that a contemporary reader might have been reminded of the opening words of Thomas Browne’s Religio medici and thought them a suitable testament for Glisson himself: “For my Religion, though there be severall circumstances that might persuade the world I have none at all, as the generall scandall of my profession, the naturall course of my studies . . . .” In fact, much more research is needed before we can begin to assess the significance of the medical profession’s reputation for irreligion and, in particular, Glisson’s own attitude to religion. Nevertheless, we can see from Henry More’s reaction to Glisson, examined below, that this leading theologian regarded Glisson’s monistic philosophy as dangerously atheistic in tendency. So far, we know little of what Glisson’s fellow physicians thought about De natura substantiae.

23 Harvey, op. cit., note 17 above.
24 Glisson, op. cit., note 5 above, especially ‘Ad lectorern’, section 11, sig. b2v-b3r, and ch. 18, section 5, pp. 234–5.
25 Ibid., ‘Ad lectorern’, sections 7 and 8, sig. a4v-b1v.
27 There are indications of an interest in theology in Glisson’s manuscripts: British Library, Sloane MS 3315, f.121-131 and Sloane MS 2251, f.117. A catalogue and index of Glisson’s papers is being prepared by Dr Jeffrey Boss and I am grateful to him for these references.
energetica, but it is clear from More's attack upon him, and Richard Baxter's defence, that its importance and relevance was recognized beyond the bounds of the medical profession.

In conclusion, then, we can say that although the Treatise on the energetic nature of substance is Glisson's only philosophical work, it cannot therefore be dismissed as a mere curiosity. It was developed as an essential complement to his medical writings and fits perfectly naturally into the rest of his oeuvre. Having relied heavily, in the Anatomia hepatis, on a concept of irritability to account for the periodic expulsion of large amounts of bile from the gall-bladder into the intestine, Glisson subsequently believed that the dependence of irritability on the presence of nerves created more problems than it solved. His development of hints from Aristotle, Galen, Van Helmont, and Harvey and his own researches on the digestive system led him to formulate his concepts of natural perception, natural appetition, and natural motion intrinsic to all body fibres. And these in turn led him to work out the implications of these ideas for general matter theory. The end result, in the Treatise of 1672, is a complete system of natural philosophy dealing not only with organic but also inorganic matter and arguing for a materialistic vitalism which could be used to cut the Gordian knot of problems associated with Cartesian dualism by showing that all matter was intrinsically alive and endowed with faculties of perception, appetition, and self-motion.

HENRY MORE AND MEDICAL IDEAS ABOUT LIFE AND THE SOUL

The major intellectual endeavour of More's career was to combat the atheism which he perceived to be increasingly prevalent among his contemporaries (educated and uneducated alike). His earliest publications, therefore, constitute what has recently been called "an important philosophical programme" by which More hoped to prove the existence of God and the immortality of the soul. In fact, it was the nature of the immortal soul which occupied most of More's attention (beginning with his Platonical song of the soul, 1642, and culminating with his Immortality of the soul in 1659) because a refusal to believe in an after-life, with its attendant notions of punishments or reward, was seen by More as likely to have the most drastic consequences on social behaviour. The "practical atheist", the libertine scoffer who had no religious and (ipso facto, according to More) no moral scruples, was the greatest threat to the smooth running of society because his behaviour was not constrained by the fear of post-mortem punishments.

These sort of people [More wrote] are very horribly afraid there should be any Spirit, lest there should be a Devil, and an account after this life; and therefore they are impatient of anything that implies it, that they may with a more full swing, and with all security from an after-reckoning, indulge their own Lusts and Humours in this.

28 Gabbey, op. cit., note 2 above, p. 222.
More elaborated his pneumatology, therefore, in an effort to provide the clearest and most forceful arguments for a personal after-life.\textsuperscript{30} In his attempt to give a comprehensive and definitive account of the nature of the soul, More realized that he could not confine himself merely to a discussion of Christian doctrines. In view of his reputation as a leading member of the Cambridge Platonists it is hardly surprising that he should also consider Platonist and neo-Platonist arguments. However, his consideration of current medical theories might seem, from our point of view, somewhat unexpected. But once we recognize the background to seventeenth-century pneumatology it becomes clear that More simply could not ignore medical theories. As D. P. Walker has shown, the eclectic neo-Platonism of the Renaissance gave rise to a number of confusions or contaminations between notions of spiritus, pneuma, and anima. Medical theories of "spirit" were especially likely to lead to such confusions, Walker has argued, because it was frequently invoked to bridge the metaphysical gap between body and soul, or matter and mind.\textsuperscript{31} By the seventeenth century, there was a tradition, well established in spite of its potentially heretical nature, which tended to identify souls with medical concepts of spirit.\textsuperscript{32} This tradition could then be drawn upon by the early mechanical philosophers to explain those aspects of mental life which men share with animals. The Cartesian res cogitans was concerned only with abstract reasoning; all other aspects of human behaviour could be explained, analogously to animal behaviour, by the motions of animal spirits through the nerves and into the muscles. As Henry More summed it up:

\begin{quote}
the Glandula Pinealis is the common Sentient or Percipient of all Objects; and without a Soul, by virtue of the Spirits and Organization of the Body, may doe all those feats that we ordinarily conceive to be performed by Soul and Body joined together. For it being one ... and so handsomely seated as to communicate with the Spirits as well of the posterior as anteriour Cavities of the Brain; by their help all the motions of the Nerves (as well those that transmit the sense of outwards Objects, as of them that serve for the inward affections of the Body, such as Hunger, Thirst and the like) are easily conveighed into it; and so being variously moved, it does variously determine the course of the Spirits into such and such Muscles, whereby it moves the Body.\textsuperscript{33}
\end{quote}


\textsuperscript{31} Walker, 'Medical spirits in philosophy ...', op. cit., note 3 above, pp. 287–289.

\textsuperscript{32} \textit{Ibid.}, p. 288; and \textit{idem}, 'Medical spirits and God and the soul', op. cit., note 3 above.

As I have argued elsewhere, Walker is perfectly correct to suggest that these heretical materialist concepts of soul contaminate even More's own concept of the soul.\(^{34}\) However, if we ignore these philosophical inconsistencies then it is true to say that More is totally committed to a dualistic belief in the existence of incorporeal substances. Essentially, these incorporeal substances fall under three headings. There is God himself, of course, and there are two different kinds of "created spirits". There are, on the one hand, all the immaterial souls of men, angels, and demons; and on the other hand, there is a ubiquitous "Spirit of Nature" pervading even deep within the densest material body. Now, More ingeniously used the mechanical philosophy to establish the existence of these immaterial substances. His early admiration for Cartesian mechanism stemmed from his belief that Descartes had shown "the just extent of the Mechanical Powers of Matter, how farre they will reach, and where they fall short." It was the short-fall that was important for More, since it enabled him to bring in the Spirit of Nature which was held to be

A substance incorporeal, but without Sense and Animadversion, pervading the whole Matter of the Universe, and exercising a Plastical power therein according to the sundry predispositions and occasions in the parts it works upon, raising such Phaenomena in the World, by directing the parts of the Matter and their Motion, as cannot be resolved into mere Mechanical powers.\(^{35}\)

If More's enterprise in natural theology was to succeed, therefore, he had to defend the immateriality of the Spirit of Nature at all costs. If he conceded any corporeality in his hylarchic principle, his whole philosophy was in danger of reduction to materialistic mechanism and became indistinguishable from the atheistic philosophy of "the most able Advocate" of materialism, Thomas Hobbes.\(^ {36}\) The Spirit of Nature, therefore, was used to explain various physical phenomena, such as the descent of bodies due to gravity, cohesion, condensation and rarefaction, magnetism, and various other phenomena which proved to be problematic for the mechanical philosophy. On biological and psychological questions, however, More did not want to rely on a universal spirit of nature since it might lead to another heresy: the denial of individual souls in favour of the Averroistic notion of a universal soul.\(^ {37}\) The Spirit of Nature, then, gives place to individual souls in living creatures:

God is not the immediate Maker of these Bodies ... Nor, is it congruous to admit that the Plastick faculty of the Soul of the World [i.e. the Spirit of Nature] is the soul contriver of these fabricks of particular creatures (though I will not deny but she may give some rude preparative strokes towards Efformation;) but that in every particular World, such as Man is especially, his own Soul is the peculiar and most perfective Architect thereof, as the Soul of the Worlds is of it.\(^ {38}\)

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\(^{34}\) See note 30 above; and Walker, 'Medical spirits in philosophy', op. cit., note 3 above, p. 289, 294.

\(^{35}\) More, Immortality, 13 and 193.


\(^{38}\) More, Immortality, 102.
In the Scholia added to his philosophical works for the Latin Opera omnia of 1679, More delineated more carefully the spheres of influence of the Spirit of Nature and the soul. Subscribing to the Aristotelian belief that the soul is not infused into an embryo until its fortieth day, he argued that the “preparative strokes toward Eiformation” of a foetus “are made by the Soul of the World, or by the Spirit of Nature”, because

in Eggs, where the soul of the mother is not present, these first lineaments are formed before the coming in of the Soul of the Chicken, as being not yet organiz’d; But particular Souls are, according to Aristotle, the Actings of an organical Body. But the Punctum saliens, or Life point, discovers not any proper sense, but only Life when it withdraws itself from any hurtful touch: as neither do what we call the Plant-Animals which I do not take to live by any proper Soul, but through the Spirit of Nature, which hath either no Sense at all, or what is very dull.39

So, although the Spirit of Nature “assists in the very first beginnings of the Generation of Animals” it is superseded, in the higher animals at least, by the creature’s individual soul.40 However, More’s “main design” was not to distinguish between the Spirit of Nature and the soul but rather “to demonstrate that there is a Soul or Incorporeal Substance residing in us, distinct from the Body”.41 Accordingly, he was compelled to discuss critically various medical theories current at the time.

For example, in order to reserve for the immaterial soul (or for the immaterial Spirit of Nature in lower animals) the architectonic or organizing power of living creatures, More had to examine and reject a common alternative view. This was the remarkable idea that “the Sun and the Stars are the most Intellectual Beings in the world, and in them is that Knowledge, Counsel and Wisdome by which all Sublunary things are framed and governed”. According to this view, the sun and stars

by their several impresses and impregnations have filled the whole Earth with vital Motion, raising innumerable sorts of Flowers, Herbs and Trees out of the ground. These have also generated the several kinds of living Creatures. These have filled the Seas with Fishes, the Fields with Beasts, and the Aire with Fowles; the Terrestrial matter being as easily formed into the living shapes of these several Animals by the powerful impress of the Imagination of the Sun and Stars, as the Embryo in the womb is marked by the strong fancy of this Mother that bears him.42

Outlandish as this may seem to us, it was an extremely common notion in More’s day. Similar arguments can be found in the work of Jean Fernel, Marsilio Ficino, Paracelsus, and even Robert Boyle. One of the ancient sources for this view is Aristotle’s De generatione animalium: “the spirit which is contained in the foamy body of the semen . . . is analogous to the element of the stars”, and it is duly considered.

39 This is taken from the English translation of the scholia which are included in the so-called “Fourth edition” of A collection of several philosophical writings, London, Joseph Downing, 1712, p. 105 (of the Immortality, like the 1662 edition the treatises are separately paginated). This is called the fourth edition because the original separate works count as the first, the 1662 Collection as the second, and the Latin Opera omnia (see note 54 below) as the third. On the time of the infusion of the soul into the embryo see John T. Noonan jun., Contraception: a history of its treatment by the Catholic Theologians and Canonists, Cambridge, Mass., Belknap Press, 1965, pp. 89-90. The locus classicus is usually taken to be Aristotle, De hist. animal., VII, 3, 583b 2–5.

40 It seems that More did not confine the concept of the immortal soul exclusively to humankind. On the immortality of animals see Immortality, 135–136.

41 Ibid., 88 [mis-numbered as 78].

42 Ibid., 52.
therefore, by that latter-day Aristotelian biologist, William Harvey, in his own *De generatione*.\(^{43}\) Nevertheless, More gave the idea short shrift. Donning his Cartesian hat, he insisted that

the sun and Stars have no immaterial Being residing in them, but are mere Matter consisting of the subtilest Particles and most vehemently agitated. For then we cannot but be assured that there is nothing in them more Divine than what is seen in other things that shine in the dark, suppose rotten wood, glow-worms or the flame of a rush candle.

And the idea that these heavenly bodies could form a creature like "the most curious Automaton that ever was invented by the wit of man" simply by "a mere Rectilinear impress upon the Aether down to the Earth" was dismissed as untenable.\(^{44}\)

More dealt similarly with other theories which suggested that the soul or the organizing power of the body was merely a special kind of material substance. Drawing from the full range of current medical theories, he refuted in turn the suggestion that actuation and guidance of the body together with perception and the other functions of the common sense could be performed by the body as a whole, the orifice of the stomach, the heart, the brain, the septum lucidum, the pineal gland, "Regius his small and perfectly-solid particle", the spinal marrow, and the animal spirits.\(^{45}\) We need not consider each of More's arguments in any detail but it should be noted that the major thrust of his discussion was to deny that matter itself is sufficient to explain perception and sentience. "This absurd Principle", as More called it, gave rise to the belief "that Organization may doe strange feats":

as if they should imagine, that though neither Silver, nor Steel, nor Iron, nor Lute-strings have any Sense apart, yet being put together in such a manner and formed as will (suppose) make a complete Watch, they may have Sense: that is to say, that a Watch may be a living creature, though the several parts have neither Life nor Sense . . .\(^{46}\)

More was so confident that he could explode this notion that he actually put it forward as an axiom in order to show that Hobbes’s "own acknowledged Principles will necessarily inferre the Existence of [immaterial substances] in the World." The twentieth axiom of *The immortality of the soul* reads:


\(^{45}\) Ibid., 77–94. As well as displaying a sound knowledge of various traditional theories of anatomical psychology, More also reveals here an awareness of recent theories propounded by J. B. van Helmont, Henricus Regius, and Rene Descartes. More, like Descartes, seems to have regarded Regius in particular as dangerously materialistic in outlook. See Nicolson (editor), op. cit., note 56 below, p. 389; and Sloan, op. cit., note 33 above, pp. 23–28.

Of course, the conditional clause is crucial to More’s case and it is just that which he then proceeded to deny. The absurdity of Axiom XX could be shown simply by pointing out that wherever there is motion so must there be sense and perception. In other words a dead carcass, a ringing bell, a bent bow, and “every Jack-in-a-box that School-boy es play with” would have to be “living Animals or Sensitive Creatures”. Furthermore, on Hobbes’s account, the communication of thoughts from one person to another can only take place by the justling of one interlocutor’s animal spirits against those of the other, “as if men should knock heads to communicate to each other their conceits of Wit.”

The essential point, then, of More’s rejection of this mechanical account of perception is that matter is totally passive:

It is sufficiently manifest from sense and experience that Matter is a principle purely passive, and no otherwise moved or modified then as some other thing moves and modifies it, but cannot move it self at all. Which is most demonstrable to them that contend for Sense and Perception in it. For if it had any such Perception it would by virtue of its Self-motion withdraw it self from under the knocks of hammers or fury of the fire, or of its own accord approach to such things as are most agreeable to it and pleasing, and that without the help of Muscles, it being thus immediately endowed with a Self-moving Power.

Matter, however, is “so stupid” that it lacks this Power of self-movement, as Hobbes, Descartes, or any strict mechanist would readily agree.

Unfortunately for More, however, not everyone was a strict mechanist and subscribed to this concept of completely passive matter. As More’s close associate, Ralph Cudworth, pointed out in his encyclopaedic survey of atheist philosophies, there were those who believed that matter was inherently active. The hylozoist, as Cudworth dubbed such a thinker, considered that all matter could move itself without muscles and that all matter could perceive and thereby could have a kind of sense without sensory organs or nerves. Cudworth was not slow to realize that hylozoism was much more dangerous to religion than the mechanical materialism (or “Atomick Atheism”) of a thinker like Hobbes.

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47 Ibid., 5, 59.
48 Ibid., 66, 86.
49 Ibid., 60. I use the term “strict mechanist” to refer to anyone who believed that matter was totally passive and inert. By no means all thinkers known to historians as mechanical philosophers were strict mechanists. I have argued elsewhere that the possibility of active matter was widely entertained among natural philosophers in seventeenth-century England: John Henry, “Occult qualities and the experimental philosophy: active principles in pre-Newtonian matter theory’ Hist. Sci., 1986, 24: 335–381.
50 Cudworth is not so careful to distinguish between perception and sensation as Glisson was. Sensation only occurs in “animate” matter, that is to say matter which is sufficiently organized to enable the simple or natural perception of matter to perceive its own perception. This perception constitutes sensation. It seems that highly organized, or animate, matter is able to dispose itself in such a way as to provide itself with special organs of sensation. This requires detailed exposition and analysis, but for now see Glisson, op. cit., note 5 above, pp. 208–216; Pagel (1953), op. cit., note 3 above, pp. 505–507.
For whereas the Atomick Atheism supposes the Notion or Idea of Body to be nothing but Extended Resisting Bulk, and consequently to include no manner of Life and Cogitation in it; Hylozoism on the contrary makes all Body, as such, and therefore every smallest atom of it, to have Life Essentially belonging to it (Natural Perception and Appetite) though without any Animal Sense or Reflexive Knowledge, as if Life, and Matter or Extended Bulk, were but two Incomplete and Inadequate Conceptions, of one and the same Substance, called Body. By reason of which life (not Animal but only Plastical) it is plain that there is no Necessity at all left, either of any Incorporeal Soul in Men to make them Rational, or of any Deity in the whole Universe to solve the Regularity thereof.\footnote{Ralph Cudworth, *The true intellectual system of the universe: the first part: wherein all the reason and philosophy of atheism is confuted: and its impossibility demonstrated*, London, Richard Royston, 1678, p. 105.}

Although Cudworth attached no names to the title hylozoist (apart from the ancient who allegedly founded the movement, Strato of Lampsacus), it is perfectly clear even from this brief extract that the Regius Professor of Hebrew had no one else in mind but the Regius Professor of Physic at Cambridge, Francis Glisson. It was only Glisson who argued in print for the natural perception and the natural appetite of matter and who regarded life and matter as two conceptus inadequati of substance.\footnote{The fact that Cudworth was attacking Glisson here has been noticed by Arrigo Pacchi, *Carlo il11ighillerra da More* ci Boyle, Roma-Bari, Editori Laterza, 1973, pp. 150-155. Cudworth’s concern with hylozoism is discussed, but with no reference to Glisson, in John W. Yolton, *Thinking matter: materialism in eighteenth-century Britain*, Oxford, Basil Blackwell, 1984, pp. 4-13. See also Colie (1957), op. cit., note 4 above, pp. 117-144.}

**HENRY MORE AND FRANCIS GLISSON**

Henry More returned to philosophical writing from more theological concerns during the preparation of his collected works, in Latin translations, for the so-called *Opes omnia* of 1679.\footnote{Henry More, *Opera omnia. tum quae latine, tum quae anglice scripta sunt; nunc vero Latinitate donata . . .*. 2 vols., London, J. Maccock and R. Norton for J. Martyn and Gualt. Kettilyb, 1679. The short title is often taken to include *Opera theologica, anglice gudem primitus scripta, nuce vero autorem latinum reddita*, London, J. Maccock for J. Martyn and Gualteri Kettilyb, 1675, as the first volume of three, but in my references I exclude this and treat the *Opera omnia* as a two-volume work.} More took the opportunity of the new edition to add scholia to his earlier philosophical works but he also published a number of short pieces for the first time.\footnote{These include a number of pieces on cabbalism (De usu decem Sephirothum, Catechismus caballisticus, and Fundamenta philosophiae sive cabalaeae aeto-paedo-melissaeae . . .), a refutation of Jacob Boehme’s theology (Philosophiae teutonicae censura), and the attack on Spinoza (see following note) which concerns us here. For a brief but important discussion of the *Cabaleae aeto-paedo-melissaeae* see C. A. Staudenbaur, ‘Platonism, theosophy and immaterialism: recent views of the Cambridge Platonists’, *J. Hist. Ideas*, 1974, 35: 157-169, which corrects the thoroughly unsound S. Hutin, *Henry More. essai sur les doctrines theosophiques chez les Platoniciens de Cambridge*, Hildesheim, G. Olms, 1966.}

One of these new pieces, *Ad. V.C. epistola altera*, was concerned to refute the thinker whom he considered to be the most dangerous atheist since Hobbes, Benedict de Spinoza. We know from a letter of More’s to Anne, Lady Conway, that this little tract was composed hurriedly while the Latin collection of his works was
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actually in press. The letter also reveals that he began writing his refutation of Spinoza’s *Tractatus theologico-politicus* even before he had finished reading the work. This is what he said to Anne:

I come thus late to London by reason of Cuperus his Confutation of *Tractatus Theologicopoliticus* which Monsieur Van Helmont gave me at Ragley from a friend in Holland, in quires. which while it was a binding at Cambridge I fell a reading Theologicopoliticus the better to understand Cuperus his confutation when it came from binding. But I found this Theologicopoliticus such an impious work, that I could not forbear confuting him while a [ste] read him. . . Proposing this Confutation of mine shall make up some part of this Philosophicall volumn.56

Spinozism, then, was regarded as a philosophical emergency which had to be treated immediately. The urgency of More’s response stems in part from the fact that Spinoza, unlike Hobbes and the Cartesians, seemed to argue that matter is inherently active and “alive”. This approach, More could hardly fail to recognize, completely undermined his previous attempts to establish the existence of incorporeal animating spirits, all of which were based on the Hobbist or Cartesian assumption that matter is completely passive and inert. It was during the course of his response to Spinozistic “living” matter that More paused in order to reject Glisson’s arguments for the “energetic nature of substance”. He took his cue from his fellow anti-Spinozist, Franciscus Cuperus:

So when Cuperus says that modern atheists nowadays believe in the innate life of matter, not in a mechanical mover, he gives a nod to some such hypothesis as the most distinguished Doctor Francis Glisson attempted to describe, with very accurate and clear arguments, in his Treatise *de Natura Substantiae Energetica, or, de Vita Naturae*. Whereas Spinoza contends that substance, in so far as it is substance, exists a se, indeed is that which subsists by itself so he [Glisson] holds that substance, *qua* substance, lives by the necessary power of its Nature, that is, it perceives, it desires and it moves itself (*percipere, appetere, sesere movere*): which faculties: perceptive, appetitive and motive; he holds, accordingly, to be immediately present in matter itself.57

There follow eight closely argued folio pages against Glisson’s philosophy and what More saw as its atheistic implications. It is clear from these pages that More had given close attention to Glisson’s *Tractatus*, and it is easy to see why. Glisson took the concept of inherently active matter further than any of his contemporaries, including Spinoza.

Since Glisson believed that the energetic nature of substance was the internal principle of movements in matter he tried to take evidence for his case “from various motions observed in Nature”. Glisson understood the word “motion”, in the


57 More, *Opera omnia*, I: 601. Glisson is mentioned on p. 601 and examined in detail pp. 604–611. Translations from these are mine.
Aristotelian sense, to mean “change” and so a number of his examples of motion may seem unfamiliar to us. Not only did he argue from the motion “of the Heavens and Planets and even the Earth itself around the Sun”, the motions caused by horror vacui and “the motion of Rarefaction and Condensation” but also from “the motion of solidity” [motus antitypiae], “the motion of coherence” [motus nexus], and “the motion of freedom” [motus libertatis] (by which he meant the elastic tendency of a compressed body, say, to return to its former state when external pressure is removed).58 Henry More attempted to refute each of these in turn. The resistance or solidity of matter cannot be used to prove the vitality of matter, he insisted, because “substance qua substance” is sufficient to explain solidity. By which, presumably, he meant that solidity is part of the definition of matter.59 Elsewhere he called upon the mechanical philosophy in an effort to show that Glisson’s vitalism was an unnecessary hypothesis. The coherence of matter can be explained more simply (so More believed!) in terms of Cartesian circular motion, the plenum, and the non-interpenetrability of matter. Similarly, “the Motus Coelorum, that is, the Vortexes, does not indicate any perceptive life in the matter of the vortexes, since such a portion of motion is impressed on them mechanically, or much more likely by some immaterial principle, that they revolve freely in these gyrations entirely without self-perception.”60 Needless to say, the immaterial principle alluded to here is More’s “Spirit of Nature”, and he invoked that in his rejection of all Glisson’s other examples of different kinds of motion. “The parts of matter”, for example, “cohere and are connected by the one universal bond of the Spirit of Nature which holds together and actuates the whole material world.” It is the hylarchic principle, then, which accounts for fuga vacui and for motus libertatis. When air is caused to expand by heating, for example, it is merely due to increased vibration of the particles and, on cooling, the air returns to its former volume “not by its own power but by virtue of the Universal Hylostatic Spirit.”61

58 I am paraphrasing, and quoting from More’s account of Glisson’s theories. See More, Opera omnia, I: 605-606. In fact, More was simplifying Glisson’s account. Glisson distinguished between perpetual and non-perpetual motions. The perpetual motions are motus antitypiae, motus nexus and motus corporum coelestium and they are discussed in the Tractatus, note 5 above, pp. 352, 354 and 355 respectively. Non-perpetual motions are more complicated and less clear. At ch. 25 (pp. 356–363) we learn that there are three kinds of non-perpetual motion depending on whether the motive principle is internal, external, or a mixture of both. In order to establish his claims about the innate motility of all matter, Glisson discounted the first of these (which is not in contention) and turned his attention to the last two kinds which he called, in keeping with the common opinion, “inanimate”. Inanimate motions are divided into five classes which embrace the other examples of “Species” of motion which More singled out. Motus libertatis is discussed at p. 375, motus condensatione et rarefactione at p. 376, fuga vacui at p. 367, but see also p. 432.

59 More, opera omnia, I: 605.

60 Ibid.

More's "confutation" of Glisson's internal principles of motion, philosophically unsatisfactory though it is, stands representative of all his arguments. He never met Glisson on his own terms but was merely content to assert that everything Glisson used to support his case actually supported the existence of the Spirit of Nature. Glisson's arguments, More somewhat petulantly insisted, "do not prove that life emanates from matter itself or that life is not communicated to it by an immaterial Principle". The point is, of course, that More was driven by his theological concerns to beg the very questions that really divided him from Glisson. At one highly significant point in his discussion More let the reason for his anxiety show: "This argument [that internal motion is a sufficient principle of life] cannot prove that matter is autozoon [self-living] and endowed with perceptive and appetitive life, unless it is previously supposed that there is no God who can create a Spirit purely Plastic and set it over the matter of the world."

According to More, then, this vitalist way of arguing was even more dangerous than Hobbist mechanism. Glisson actually seemed (by implication) to take providence out of God's hands and to implant that too directly within matter when he asked "Is Nature so far fortuitous that it begins a new operation of its own record without any purpose to itself? or does it rather manage all things wisely and not without admirable providence?" It was speculations like these which led More to denounce Glisson's philosophy in the strongest terms: "Only those who deny God and all incorporeal substance; strive to seek the origin of motion and all life which gleams in the universe in matter itself."

More clearly announced that Glisson's philosophy "should certainly carry some weight with those who deny any substance beyond body. For, then it may be reasonable enough to decide that a kind of life is immediately and primaevally present in matter, whose characteristic properties of life; which are thought to be, and are called 'souls' by the vulgar; are only various modifications of matter . . ." More agreed, therefore, with Franciscus Cuperus that "modern atheists . . . having forsaken mechanical reasons for the created world, take up [a belief] in the primitive life of matter."*62

* More clearly announced that Glisson's philosophy "should certainly carry some weight with those who deny any substance beyond body. For, then it may be reasonable enough to decide that a kind of life is immediately and primaevally present in matter, whose characteristic properties of life; which are thought to be, and are called 'souls' by the vulgar; are only various modifications of matter . . ."

* More, Opera omnia, I: 607.

* Ibid. This is a quotation from Glisson's ch. 17, sect. 3 (as More tells us). It is to be found in Glisson, op. cit., note 5 above, p. 226. The point of Glisson's rhetorical questions was to affirm that matter must have perception and appetite: "I am unable to conceive how it happens that motion arises purely from an internal principle; yet that principle neither desires nor perceives."

* More, Opera omnia, I: 607.

* Ibid., p. 608.

* Ibid. See also p. 611 where More concluded that the "modern atheists", of whom Cuperus speaks, "who profess a vital principal in the created World, but because of life arising from matter itself, and who do not believe that there is anything in nature beyond this living matter, can scrape together for themselves nothing from the writings of Glisson by which they very greatly support their cause." I should point out that the charge of atheism was an extremely serious one at the time and, consequently, More pointed out that Glisson "not only acknowledges but so often insists upon the existence of the Creator God and other incorporeal substances", p. 607. As we shall see, it is perfectly possible to propound a natural philosophy like that of Glisson and still remain within the traditions of voluntarist theology.
It seems likely, then, that it was More’s obsessive fear of atheism which inhibited his philosophical analysis of Glisson’s *Tractatus* and prevented him from providing any really cogent counter-arguments. More’s response is best characterized as merely a series of desperate reiterations of the role of the Spirit of Nature in the fabric of the World. Consider this final example:

it is thoroughly manifest that the most learned Glisson has put forward no argument of any import, neither *a priori* nor *a posteriori*, which might prove the Energetic Nature of Substance... since those patterns of life which seem to appear in matter could be brought about by some immaterial Principle. 67

What is worse, More compounded this kind of unsatisfactory procedure with an exercise in question-begging of astonishing impudence. The principle which More invoked (against Glisson) to account for movements, perception, and other “patterns of life” must certainly be *immaterial*, More brazenly insisted, “because it dictates each of the motions of Matter”. 68

**IN DEFENCE OF GLISSON: RICHARD BAXTER’S POLEMIC WITH MORE**

We would be making a serious mistake if we assumed that More’s attack on Glisson as a comforter of atheists represented any kind of consensus. Writing at a time when there was little consensus among theologians in general, More was regarded by a number of his contemporaries as precariously idiosyncratic. 69 But what is significant

67 More, *Opera omnia*, I: 608.

68 Ibid. More’s failure to confront Glisson’s arguments and his monotonous reminders of the existence of a “Spirit of Nature”, which he claimed to have proved in his earlier writings, clearly testify to the intense fear of atheism that gripped him. But I think the marked intensity of More’s commitment to the dualist distinction between matter and a preternatural actuating principle also illustrates an important insight to be found in R. S. Westfall, *Science and religion in seventeenth-century England*, New Haven, Conn., Yale University Press, 1958. Westfall, speaking of seventeenth-century natural theologians, said that “Despite the natural piety of the virtuoso, the scepticism of the Enlightenment was already present in embryo among them” (p. 219). The origins of their doubts, Westfall suggested, lay in the many objections to traditional religion, “which were too close to their own beliefs to be ignored” (p. 145). In developing their natural theologies, therefore, “More than answering hypothetical atheists, they were trying to satisfy their own doubts” (p. 145). More was not a man who suffered from doubts but he was all too aware of how close Glisson’s ideas were to his own. Indeed, at one point. More said of Glisson: “If he had put for ‘Nature’ the ‘Spirit of Nature’ that would have been enough for us to agree” (*Opera omnia*, I: 606). The closeness of Glisson’s ideas to those of More and Cudworth have also been noticed by Owsei Temkin (see his article in *DSB*, 5: 426-427). And yet, no matter how close they seem, the difference between them is absolutely crucial. Perhaps More felt that by expounding Glisson’s arguments in order to refute them he would stimulate more interest in them. He certainly felt that he had made this kind of error before. As he wrote to Robert Boyle on 4 December 1671, “I have, from my very first letters to Descartes, till this last book of mine, always expressed my opinion, that this mechanical way would not hold in all phenomena, as I always verily thought: but this would not save us from being accounted amongst the wits, one of their gang; and a perfect Cartesian... and, indeed, no less than an infidel and an atheist”; in Robert Boyle, *The works*, 6 vols., London, J. & F. Rivington, L. Davis, et al., 1772, vol. 6, p. 513. In Glisson’s case, then, More chose not so much to refute it as to pronounce it to be wrong. For a further discussion of similarity between More’s and Glisson’s ideas see Henry op. cit., note 30 above.

69 The fullest discussion of More’s unorthodoxy is to be found in Samuel Parker, *A free and impartial censure of the Platonick philosophie*, Oxford, W. Hall for Richard Davis, 1666, especially pp. 79-83. Boyle, op. cit., note 61 above, referred to More’s *Principium Hylarchicum* as a “precarious Principle” in theology as well as natural philosophy, as did Sir Matthew Hale, *Observations touching the principles of natural motions;... together with a reply to certain remarks touching the gravitation of fluids*, London, W. Godbid for W. Shrowsbury, 1677, p. 282. Moreover, More felt the need to defend his ideas not by recourse to
for our discussion is the fact that just two years after the appearance of More’s *Ad. V.C. epistola altera* Glisson’s name appeared once again in a theological context; but this time he was cited with approbation. Richard Baxter, in his *Methodus theologiae christianae* (1681), deferred twice to Glisson. Once, in the preface, on the subject of the active principle in nature, and once on the subject of “Virtus activa vitalis”. The precise meanings of these references are (at least to this reader) somewhat obscure but, fortunately, Baxter expanded his views on active principles and on Glisson’s *De natura substantiae energetica* in a letter to Henry More written in the same year. It was written at More’s request because “It seemed good to the worthy Dr. to desire my thoughts of his Description of a Spirit, which he laid down in the first Edition of Mr. Glanvill’s *Apparitions*”. The fact that More published a long reply to this private letter (in the second edition of Glanvill’s *History of apparitions*) is powerful testimony to More’s sensitivity to criticism on this issue and of his protective ness towards his concept of spirit. This reply, entitled *A letter to a learned psychopyrist*, appeared early in 1682; whereupon, within months, Baxter published his original letter, together with a defence of it in a discourse *Of the nature of spirits*. However, the last word on the matter went to More (again a sign of the importance More attached to his own style of pneumatology), this time writing as the anonymous commentator on Bishop Rust’s *Discourse of truth*. This polemic, so far completely overlooked, contains a good deal of interest for the intellectual historian but, for the sake of brevity, we will confine ourselves here to those parts of the dialogue which involve Glisson.

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71 Richard Baxter, *Of the immortality of mans soule, and the nature of it, and other spirits. Two discourses: one in a letter to an unknown doubter; the other in a reply to Dr. Henry More’s animadversions on a private letter to him; which he published in his second edition of Mr. Joseph. Glanvill’s Sadducismus triumphatus, or history of apparitions*. London, for B. Simmons, 1682, Sig. a4r. See note 29 above for full citation of the first edition of Glanvill’s *Sadducismus*: the second edition, which includes More’s ‘Letter to a learned psychopyrist’, appeared in the first months of 1682 (new style). More’s first letter to Baxter soliciting his opinion on the concept of spirit is extant in the Baxter MSS at Dr Williams’s Library. Baxter Letters, III, f.286 (it is dated 25 September 1681).

72 Joseph Glanvill [and George Rust], *Two choice and useful treatises: the one Lux Orientalis or an enquiry into the opinion of the eastern sages concerning the preexistence of souls. Being a key to unlock the grand mysteries of providence, in relation to mans sins and misery. The other a discourse of truth, by the late Reverend Dr Rust Lord Bishop of Dromore in Ireland. With annotations on them both*, London, for James Collins and Sam Lowndes, 1682. More’s annotations on Rust have a separate title page which reads: *Annotations upon the discourse of truth into which is inserted by way of digression, a brief return to Mr. Baxter’s reply, which he calls a plagiat collusion with the learned Dr. Henry More, occasioned by the Doctors answer to a letter of the learned psychopyrist*. . . . The digression is found pp. 180–246. Hereinafter cited as More, *Digression*. The annotations are unsigned but they are almost certainly by More. See Nicolson, op. cit., note 56 above, p. 173; and Walker, op. cit., note 29 above, 126, 131.

73 The only other discussion of this polemic which I am aware of considers it in the broader context of late seventeenth-century discussions of the nature of spirit: Robert Crocker, ‘An intellectual biography of Henry More, 1614–1687’, ch. 8 of a thesis to be presented at Oxford University for the DPhil. I am grateful to Mr Crocker for allowing me to read this prior to submission. One of the few historians to embark on a serious study of Richard Baxter in recent years is William M. Lamont but even he failed to notice this polemic. More subsequently accused Baxter of writing against his views on the Apocalypse as revenge against More’s “booke of spirits”. Lamont points this out but he seems entirely unaware of their earlier polemic. See W. M.
Occult Qualities and the Experimental Philosophy: Active Principles in Pre-Newtonian Matter Theory

1 I include Hobbes even though his mature system of natural philosophy, De corpore was not published until 1665 because he began to develop his system in the 1630s. The delayed publication of his system is in itself an indication of the difficulties which Hobbes had to surmount before he was satisfied. For a discussion of Hobbes clearly efforts in natural philosophy see Jean Jacquot, Sir Charles Cavendish and his learned friends Annals of Science, viii (1952), 1367, 175191; and Frithiof Brandt, Thomas Hobbes mechanical conception of nature (Copenhagen and London, 1928).

2 The quotation is from Mr Petty’s letter in answer to Mr. More (c. 1647) which is reprinted in Charles Webster, Henry More and Descartes: Some new sources The British journal for the history of science, iv (1969), 359177, p. 367.


4 Henry More, letter to Descartes (23 July 1649), and Responsio ad fragmentum cartesii to Claude Cleriselier (JulyAugust 1655), both quoted from Alan Gabbey, Philosophia cartesiana triumphata: Henry More (16461671) in T. M. Lennon, J. M. Nicholas and J. W. Davis (eds), Problems of Cartesianism (Kingston and Montreal, 1982), 171230, 211 and 213; see also 192.

5 The two philosophers who spring most readily to mind are Newton, whom we shall discuss below, but see also Ernan McMullin, Newton on matter and activity (Notre Dame and London, 1978); and Leibniz. On Leibniz’s rejection of passive matter as an ontological impossibility see Walter Pagel, The religious and philosophical aspects of Van Helmont’s science and medicine Supplements to the Bulletin of the History of Medicine, ii (1944), 2784; C. D. Broad, Leibniz: An introduction (Cambridge, 1975), 4911; and Alan Gabbey, Force and inertia in seventeenth-century dynamics Studies in the History and Philosophy of Science, ii (1971), 167, pp. 118. But, of course, not even Descartes managed to confine his system to a concept of passive matter. See ref. 107 below and Mary B. Hesse, Action at a distance in E. McMullin (ed.), The concept of matter in modern philosophy (Notre Dame and London, 1963), 119127, p. 122; Thomas L. Prendergast, Motion, action and tendency in Descartes physics Journal of the History of Philosophy, xiii (1975), 45362; and Gary C. Hatfield, Force (God) in Descartes physics Studies in the History and Philosophy of Science, x (1979), 113120.

6 R. S. Westfall, Newton and alchemy in Brian Vickers (ed.), Occult and scientific mentalities in the Renaissance (Cambridge, 1984), 31535, pp. 317, 324, 326, 323, 326. 7The suggestion that Newton’s interest in alchemy stemmed from his efforts to understand the active principles in matter was first made in J. E. McGuire, Force, active principles and Newton’s invisible realm Ambix, xv (1968), 154168, p. 166. Since then the notion has been taken up and elaborated in P. M. Rattansi, Newton’s alchemical studies and R. S. Westfall, Newton and the Hermetic tradition both in A. G. Debus (ed.), Science, medicine and society in the Renaissance (New York, 1972), 167182 and 183193 respectively; R. S. Westfall, The role of alchemy in Newton’s career in M. L. Righini Bonelli and W. R. Shea (eds), Reason, experiment and mysticism in the Scientific Revolution (London, 1975), 189192; idem, op. cit. (ref. 6); and B. J. T. Dobbs, Newton’s alchemy and his theory of matter Isis, lxiii (1982), 511528. On the influence of Cambridge Platonism see J. E. McGuire, Neoplatonism and active principles: Newton and the Corpus hermeticum in R. S. Westman and J. E. McGuire, Hermeticism and the Scientific Revolution (Los Angeles, 1977), 95124.

70 8 Westfall, Newton and the Hermetic tradition (ref. 7), 185. Newtonian hagiography has been taken to new heights in Westfall’s biography Never at rest (Cambridge, 1980), in which Westfall expresses his conviction that Newton was wholly other and that with him there is no measure (p. ix).

9 R. Descartes, Principia Philosophiae, IV, 199: Qu’il n’a aucun phainomene en la nature qui ne soit compris en ce qui a est expliqué en ce traité.
10See above, refs 4 and 5.

11For an excellent discussion of the latter problem together with other difficulties encountered by mechanical philosophers see Alan Gabbey, The mechanical philosophy and its problems: Mechanical explanations, impenetrability, and perpetual motion, in J. C. Pitt (ed.), Change and progress in modern science (Dordrecht, 1985), 96ff. There is, unfortunately, no survey of critical responses to Descartes among natural philosophers and the material which springs most readily to mind is in Newton's work. Consider, for example, his Questions quaedam philosophicae, now published as J. E. McGuire and Martin Tamny (eds), Certain philosophical questions: Newton's Trinity notebook (Cambridge, 1983); and De gravitatione et aequipondio fluidorum, translated and discussed in A. R. Hall and M. Boas Hall (eds), Unpublished scientific papers of Isaac Newton (Cambridge, 1962), 75ff. But see also the works by Glanvill cited above (ref. 3); and Robert Boyle, An essay of languid and unheeded motions (1685), chapter 5: Of the propagable nature of motion which includes many examples of new motions and of new experiments about explosion (1672) which can be found in The works, edited by Thomas Birch (6 vols, London, 1772), v, 12ff, and iii, 592ff, respectively.


14His papers were known to Thomas Hobbes, John Wilkins, Ralph Bathurst and others. See Jacquot (refs 1 and 13) and [John Wilkins and Seth Ward], Vindiciae academiarum containing some brief animadversions upon Mr Webster's book, stiled, The examination of academies (Oxford, 1654), 7 and 53.

15Walter Charleton, Physiologia Epicuro-Gassendo-Charltoniana: Or a fabrick of science natural upon the hypothesis of atoms (London, 1654). For the influence of this on Newton see R. S. Westfall, The foundations of Newton's philosophy of nature, The British Journal for the History of Science, i (1962), 171ff; Henry Guerlac, Newton et Epicure, Essays and papers in the history of modern science (Baltimore, 1977), 82ff; and McGuire and Tamny, op. cit. (ref. 11), 26ff.

16Charleton, op. cit. (ref. 15), 126, 269.


18J. B. van Helmont, A ternary of paradoxes; the magnetical cure of wounds, the nativity of tartar in wine, the image of God in man, translated, illustrated and amplified by Walter Charleton (London, 1650), sig. D4v, D2r, C2r.

19Walter Charleton, The darknes of atheism dispelled by the light of nature: A physicotheological treatise (London, 1652), 47, 44, 46. See also the following section of this article. It should be clear from what has been said here that the claim that Charleton's work shows a dramatic change from an overwhelmingly Renaissance-alchemical position to a blatantly atomistic and modern approach is misconceived. See N. Rattner Gelbart, The intellectual development of Walter Charleton, Ambix, xviii (1971), 149ff, pp. 149ff. Gelbart was extending here a view proposed by P. M. Rattansi, Paracelsus and the Puritan Revolution, Ambix, xi (1963), 24ff. In fact, these views are casualties of the mistaken historiography I am seeking to correct. Providing we realize that it was perfectly possible to amalgamate atomist heuristic with Paracelsian/Helmontian and similarly alchemical and vitalistic world views (see ref. 17), then we can begin to read Charleton and other English mechanical philosophers' works aright. For another critique of Gelbart's views from a different perspective see Lotte Mulligan, Reason, right reason and revelation in mid-seventeenth-century England, in Jn Vickers (ed.), op. cit. (ref. 6), 375ff, pp. 379ff.

37120[Matthew Hale Sir], Observations touching the principles of natural motions; and especially touching rarefaction and condensation: Together with a reply to certain remarks touching the gravitation of fluids (London, 1677), 3ff. Hale has yet to receive full scholarly attention. In the meantime see Matthew Hale Sir, The works, moral and religious, to which are prefixed his life and death by Bishop Burnet, D.D. and an appendix to the life, including the additional notes of Richard Baxter (London, 1805); and Edmund Heward, Matthew Hale (London, 1972).

21Hale, Observations (ref. 20), 8, 9, 13, 10. On Newton's drafts for the Queries see McGuire, Force, active principles and Newton's invisible realm (ref. 7), 171. The quotation
appears in Cambridge University Library, Add. MS 3970, f. 620r.
22 Henry Power, Experimental philosophy, in three books: Containing new experiments, microscopical, mercurial, magnetic. With some deductions and probable hypotheses, raised from them in avouchment and illustration of the now famous atomical hypothesis (London, 1664), sig. b4r, b3v, c2r, p. 61.
Francis Glisson, Tractatus de natura substantiae energetica, seu de vita naturae eiusque tribus primis facultatibus I. perceptiva, II. appetitiva, et III. motiva (London, 1672). Glisson’s ideas on the energetic nature of substance were first mooted in his Anatomia hepatitis (London, 1654) and there are clear antecedents for them in the medical tradition and particularly in Van Helmont and Harvey. As we saw earlier with Charleton, writers in the medical tradition were often most free with concepts of active matter. See Owsei Temkin, The classical roots of Glisson’s doctrine of irritation, Bulletin of the History of Medicine, xxxviii (1964), 297–328; Walter Pagel, Harvey and Glisson on irritability with a note on Van Helmont, Bulletin of the History of Medicine, xli (1967), 497–504; idem, New light on William Harvey (Basel, 1976), 346; idem, Joan Baptista van Helmont, reformer of science and medicine (Cambridge, 1982), 120–123; and John Henry, Medicine and pneumatology: Henry More, Richard Baxter and Francis Glisson’s Treatise on the energetic nature of substance. Medical history, forthcoming. For more general treatments of the role of active matter in the medical tradition, see W. Pagel, Paracelsus: An introduction to philosophical medicine in the era of the Renaissance (2nd edition, Basel, 1982); idem, New light on William Harvey (Basel, 1976), 211–274, 636–646, 741–749; and Owen Hannaway, The chemists and the word: The didactic origins of chemistry (Baltimore and London, 1975), 24, 29, 34.
24 Vegetation of metals is the working title of Newton scholars for Burndy MS 16 with the incipit Of Natures obvious laws & processes in vegetation. The quotation is from f.5r. It is discussed in Rattansi and Westfall’s Essays on Newton’s alchemy cited in ref. 7, and in B. J. T. Dobbs, Newton manuscripts at the Smithsonian Institution, lviii (1977), 105–107; and idem, op. cit. (ref. 7), 517–519. The quotation from the alchemical Propositions is taken from the latter, p. 515. For a full survey of Newton’s alchemically written see B. J. T. Dobbs, Foundations of Newton’s alchemy, or The Hunting of the Greene Lyon, 372–385 Burndy MS 16, f.3r. For a discussion offlamma vitalis and fermentation in biomedical thought see Douglas McKie, Fire and the fiamma vitalis: Boyle, Hooke and Mayow in E. A. Underwood (ed.), Science, medicine and history: Essays on the evolution of scientific thought and medical practice written in honour of Charles Singer (2 vols, London, 1953), i, 469–478; Everett Mendelsohn, Heat and life, the development of the theory of animal heat (Cambridge, 1964), 276; A. B. Davis, Circulation physiology and medical chemistry in England 1650–1800 (Lawrence, Kansas, 1973); and R. G. Frank Jr., Harvey and the Oxford physiologists: Scientific ideas and social interaction (Berkeley, 1980).
25 Thomas Willis, A medico-philosophical discourse of Fermentation; or, Of the intestine motion of particles in every body in Dr Willis’s Practice of physick, being the whole works translated by S. Porage (London, 1684), 9. On Willis see Davis, op. cit. (ref. 25), 81–82; Frank, op. cit. (ref. 25), 165–169, 221–224, 232–237, 248–250; and T. S. Hall, Ideas of life and matter (2 vols, Chicago, 1969), i, 312–325. On Mayow see Frank, op. cit. (ref. 25), 224–258; and Hall, i, 326–36. On Lower see Frank, 188–205, 208–220; and Hall, i, 337–342. 27 Newton, op. cit. (ref. 12), 399–400, see also 401. Cf. McGuire, Force, active principles and Newton’s invisible realm (ref. 7), 171; and Dobbs, op. cit. (ref. 7), 515–519.
30 Boyle, Works (ref. 11), iv, 85–94, p. 90. Hall, op. cit. (ref. 26), i, 291–292, discusses the Paracelsian nature of these and similar ideas in Boyle’s writings.
The concept of powers or faculties is a highly complex philosophical notion and should be treated with some care. For philosophical analyses of the concept in both Boyle and Locke, see F. J. O’Toole, Qualities and powers in the corpuscular philosophy of Robert Boyle Journal of the History of Philosophy, xxii (1974), 295-315. Peter Alexander, Ideas, qualities and corpuscles: Locke and Boyle on the external world (Cambridge, 1985), especially pp. 150-167; and R. M. Mattern, Locke on active power and the obscure idea of active power from bodies Studies in the History and Philosophy of Science, xi (1980), 397-399. O’Toole argues that for Boyle powers cannot simply be reduced to the primary (mechanical) qualities but are a function of those qualities (pp. 310-311); Alexander, similarly, argues that powers may be intrinsic properties of things but only by virtue of being entailed by the primary qualities (p. 160). Clearly they both feel that powers can be explained, ultimately, in strictly mechanist terms. I differ from them in this. I feel that they are further victims of the prevailing historiography. Alexander, for example, insists that Boyle was suspicious of occult qualities and Newtonian forces. As we have seen, this is not necessarily so and we will try to explain why some occult qualities were acceptable to the mechanical philosophers in the third section of this article. Keith Hutchison has already pointed out the tendency of historians (and philosophers) to misread the evidence on this matter and has argued that seventeenth century natural philosophers only rejected certain kinds of occult quality; see his importantly revisionist paper: Keith Hutchison, What happened to occult qualities in the Scientific Revolution? Isis, lxxiii (1982), 233-253, pp. 235, 252. Of course, given his probabilistic outlook (see ref. 29 and L. Laudan, The clock metaphor and probabilism: The impact of Descartes on English methodological thought, 1650-1700 Annals of Science, xxii (1966), 73-104), Boyle no doubt thought it possible that one day all powers of bodies would be explained in strict mechanist terms but, by the same token, he could also entertain the possibility that there may be other ways of working. Such notions were perfectly acceptable providing they could be investigated experimentally (see third section of this article). For an excellent defence of these ideas by a philosopher of science see R. Harré, British Journal for the Philosophy of Science, xx (1970), 81-101.

31 Boyle, Works (ref. 11), iv, 79.
32 Boyle, Works (ref. 11), iii, 306, p. 306; 316-315, p. 316. For further examples see ch. 5 of this essay, Of the propagable nature of motion. See also Hall, op. cit. (ref. 26), i, 287.
33 Boyle, Suspicions about some hidden qualities of the air (1674), Works (ref. 11), iv, 85, p. 89, and Of the great effects of languid and unheeded motions (1685), Works (ref. 11), v, 1-2, pp. 26-27.
34 Boyle, Languid and unheeded motions, Works (ref. 11), v, 14. For further examples see ch. of this essay, Of the propagable nature of motion. See also Hall, op. cit. (ref. 26), i, 287.
36 Boyle, Excellency and grounds, Works (ref. 11), iv, 72; General history of the air, Works, v, 615. Cohen (ed.), op. cit. (ref. 28), 181, 179. See also Robert Boyle, An explication of rarefaction, Works, i, 179-180: New experiments physico-mechanical touching the spring of the air, Works, i, 12; The history of fluidity and firmness, Works, i, 387; Of absolute rest in bodies: An essay of the intestine motions of the particles of quiescent solids, where the absolute rest of bodies is called in question, Works, i, 443-457; Historical account of a strangely self-moving liquor, Works, v, 71-73. And Hall and Hall (eds), op. cit. (ref. 11), 224.
37 Robert Hooke, Micrographia: Or some physiological descriptions of minute bodies made by magnifying glasses, with observations and inquiries thereupon (London, 1665), 16.
38 Robert Hooke, The posthumous works, ed. by Richard Waller (London, 1705), 166, 184.
39 Henry More, The second lash of Alazonomastix laid on in mercie upon that stubborn youth Eugenius Philalethes: Or a sober reply to a very uncivill answer to certain observations upon Anthroposophia Theomagica and Anima magica abscondita (London, 1651), 67. Occasionally, of course, it is possible to find Hooke attempting to give a strict mechanical account of such vibrations. Cf. De potentia restitutiva: This Vibrative motion I do not suppose inherent or inseparable from the Particles of body, but communicated by Impulses given from other bodies in the Universe, in R. T. Gunther (ed.), Early science in Oxford (14 vols, Oxford, 1921-1935), viii, 340. Presumably Hooke’s inconsistency stems from the specific occasion of each utterance. An awareness of the kind of criticism that might be levelled at him from a Cartesian or even a theologian like More might stimulate a greater
confidence in strict mechanism than on other occasions.

40 Marie Boas Hall, *The establishment of the mechanical philosophy* (Osiris, x (1952), 412-441, p. 417.

374 41 Hooke, *Micrographia* (ref. 37), 127.

42ibid., 28, 22.

43 These speculations appear in Query 21 of Newton's *Opticks* and in his letter to Robert Boyle of February 1679, which is reprinted in Cohen (ed.), *op. cit.* (ref. 28), 250-253. See also Newton's De aere et aethere in Hall and Hall (eds), *op. cit.* (ref. 11), 214-228.


46 Walter Charleton, *Natural history of nutrition, life and voluntary motion: Containing all the new discoveries of anatomists* and most probable opinions of physicians, concerning the oeconomy of human nature (London, 1659), 13; Willis, *op. cit.* (ref. 26), 1.

47 Boyle, *Of the admirably differing extension of the same quantity of air rarefied and compressed* (Works, *op. cit.* (ref. 11), iii, 509. See also, Works, i, 117-120, 178-182; ii, 503-504; iii, 278-279; v, 28.


49 Kenelm Digby Sir, *Two treatises. In the one of which the nature of bodies; in the other the nature of mans soule is looked into: In way of discovery of the immortality of reasonable souls* (Paris, 1644), 21.

50 Hall and Hall (eds), *op. cit.* (ref. 11), 317 (Latin, p. 314); see also 306 (303), 341 (328). Newton had read Digby's *Two treatises* early in his career. See Westfall, *op. cit.* (ref. 15), 172; J. E. McGuire, *The origin of Newton's doctrine of essential qualities* (Centaurus, xii (1968), 233-260, pp. 244-266. Westfall has not made this connection between Newton's net-like matter and anti-atomist arguments but has linked it instead to Newton's searches for the alchemical net. See Westfall, *op. cit.* (ref. 8), 389, 508-509; and idem, *Alchemy in Newton's career* (ref. 7), 209-210. See also Dobbs, *Foundations of Newton's alchemy* (ref. 24), 161-163.

51 Hall and Hall (eds), *op. cit.* (ref. 11), 223, (Latin, p. 216).

52 Westfall, *op. cit.* (ref. 6), 317; and idem, *op. cit.* (ref. 28), 377.

53 Matthew Hale Sir, *Dificiles nugae: Or, observations touching the Torricellian experiment, and the various solutions of the same, especially touching the weight and elasticity of the air.* The second edition with some occasional additions (London, 1675), 181. Kenelm Digby Sir calculated that the proportion of empty space to matter in air must be at least as disparate as 7,600 to 1. This was based on the assumption that gold was completely free of void interstices and was 7,600 times denser than air. Digby, *op. cit.* (ref. 49), 202. Digby drew his figures from Marinus Ghetaldus, *Promotus archimedis seu variis corporum generibus gravitate et magnitudine comparatus* (Rome, 1603), 32.

54 Hale, *op. cit.* (ref. 53), 183.

55 Charleton, *op. cit.* (ref. 19), 47.


57 Petty, *op. cit.* (ref. 56), 125-126.

58ibid., 126-120.


60 Letter from More to Anne, Lady Conway, 5 July 1662, reprinted in M. H. Nicolson (ed.), *Conway letters: The correspondence of Anne, Viscountess Conway, Henry More, and their friends*, 1642-1684 (New Haven, 1930), 204. See above at ref. 4.
61 Letter from More to Boyle, 4 December 1671, reprinted in Boyle, Works (ref. 11), vi, 513. This letter has frequently been dated to 1665; for a discussion of the dating of this letter and the best discussion of More’s relationship to Descartes see Gabrey, op. cit. (ref. 4), 284n. On Hobbes as an atheist see S. I. Mintz, The hunting of Leviathan: Seventeenth-century reactions to the materialism and moral philosophy of Thomas Hobbes (Cambridge, 1970).

62 Newton, op. cit. (ref. 12), 397. Boyle, Some considerations touching the usefulness of experimental natural philosophy (1663), Works (ref. 11), ii, 42-43; see also Origin of forms and qualities, Works, iii, 15. Consider also ch. 3 of Matthew Hale Sir, Magnetismus magnus: Or, metaphysical and divine contemplations on the magnet or loadstone (London, 1695), 13-14: THe evidence of the existence of the Glorious God, from the supposition of a self-moving principle in Nature and Charleton, op. cit. (ref. 15), 436.

63 See R. Descartes, Principia Philosophiae, ii, 39; and R. Hooykaas, Religion and the rise of modern science (Edinburgh and London, 1973), 192. The literature on Malebranche is vast but see, for our purposes, Charles J. McCracken, Malebranche and British philosophy (Oxford, 1983).

64 Isaac Barrow, Cartesiana hypothesis de materia et motu haud satisfacit praecipuis naturae phaenomenis (1652), reprinted in Theological works, ed. by A. Napier (9 vols, Cambridge 1859), ix, 79-104. I quote from the extensive translated extracts in Percy H. Osmond, Isaac Barrow, his life and times (London, 1944), 31.

65 Joseph Glanvill and George Rust, Two choice and useful treatises: the one Lux orientalis or an enquiry into the opinion of the eastern sages concerning the praeexistence of souls and the other a discourse of truth with annotations on them both [by Henry More] (London, 1682), 10, and annotations upon Lux orientalis [separately paginated], 9.

66 Boyle, A free inquiry into the vulgarly received notion of Nature, Works (ref. 11), v, 159-254, pp. 165, 162; see also A disposition about the final causes of natural things (1688), Works, v, 399.

67 Boyle, A free inquiry, 163, and also 162-63. An understanding of the distinction between God’s absolute and ordinary powers or concourses is crucial here. For reliable guidance which relates directly to Boyle’s notion of nature see J. E. McGuire, Boyle’s conception of nature (Journal of the History of Ideas, xxxii (1972), 523-542. For further discussions see idem, Force, active principles and Newton’s invisible realm (ref. 7), 187-194; Francis Oakley, Christian theology and the Newtonian science (Church History, xxx (1961), 433-457; and idem, Omnipotence, covenant, & order: An excursion in the history of ideas from Abelard to Leibniz (Ithaca and London, 1984).

68 Charleton, op. cit. (ref. 19), 46; [ Matthew Hale Sir, ] An essay touching on the gravitation, or non-gravitation of fluid bodies, and the reasons thereof: The second edition with some occasional additions (London, 1675), 44.

69 Westfall, op. cit. (ref. 8), 509-10. The fact that Newton reverted to naturalistic explanations can be seen in the Queries to the Opticks but it is also well brought out in David Kubrin, Newton and the cyclical cosmos: Providence and the mechanical philosophy (Journal of the history of ideas, xxviii (1967), 325-346. The evident reluctance of English natural philosophers to involve God directly in their natural philosophies, as Westfall has perceptively noted, prepared the ground for the deists of the Enlightenment, op. cit. (ref. 29), 219. Similarly, in a recent essay Westfall has argued that Newton was a crypto-deist in spite of himself: idem, Newton’s theological manuscripts in Bechler (ed.), op. cit. (ref. 44), 129-143, p. 140.


72 Hale, Observations (ref. 20), 28.

73 There is a vast body of seventeenth century literature devoted to the refutation of atheism as though it is a serious presence in contemporary mores. Much of this literature attacks the new philosophy as a major source of encouragement for atheists. This topic is yet to receive definitive treatment but in the meantime see Westfall, op. cit. (ref. 29); Michael Hunter, Science and society in Restoration England (Cambridge, 1981), 162-187; and John Redwood, Reason, ridicule and religion: The age of enlightenment in England (London, 1976).
74 Henry More, Enthusiasmus triumphatus: Or, a brief discourse of the nature, causes, kinds, and cure of enthusiasm (London, 1656), quoted from A collection of several philosophical writings (London, 1662), 1.

75 Ibid., 30, 31; see also 36.

76 I have argued this more fully in Henry, op. cit. (ref. 23).

77 Perceptive or appetitive matter was directly linked to the automotive power of matter by Francis Glisson, op. cit. (ref. 23), and was an explicit feature of many biomedical theories, see immediately below. On Boyle’s rejection of these ideas see ref. 107 below. It should be noted that Bentley’s second Boyle lecture was entitled Matter and motion cannot think: Or a confutation of atheism from the faculties of the soul. The most convenient study of Newton’s belief in active matter is McMullin, op. cit. (ref. 5).

78 See ref. 23 above.

79 On the contrary, Locke felt compelled by his voluntaristic theology (a theological viewpoint he shared with virtually every mechanical philosopher in seventeenth century England) to admit the possibility of thinking matter. See, for example, John Locke, An essay concerning human understanding (London, 1706), IV, iii, 6. I will return to the voluntaristic demand for the acknowledgement of active matter as, at least, a possibility below. For a discussion of thinking matter in Locke’s work see M. D. Wilson, Superadded properties: The limits of mechanism in Locke’s work see M. D. Wilson, Superadded properties: The limits of mechanism in Locke’s American Philosophical Quarterly, xvi (1979), 143-150, which should be supplemented with Edwin McCann, Locke’s mechanism in A. J. Holland (ed.), Philosophy, its history and historiography (Dordrecht, 1985). 209-211; and John Yolton, Thinking matter: Materialism in eighteenth-century Britain (Oxford, 1984). The claim that Locke’s philosophy is indebted to his medical training in various ways has been made in Patrick Romanell, John Locke and medicine: A new key to Locke (New York, 1984); see also Kenneth Dewhurst, John Locke (1632-1704): Physician and philosopher. A medical biography (London, 1963).

80 This is essentially the thesis of J. R. Jacob and M. C. Jacob, The Anglican origins of modern science: The metaphysical foundations of the Whig constitution (Isis, lxxi (1980), 251-267; and is implicit in much of their other work. See for example, J. R. Jacob, Henry Stubbe, radical Protestantism and the early Enlightenment (Cambridge, 1983); and M. C. Jacob, The Newtonians and the English Revolution, 1689-1720 (Hassocks, 1976). It should be apparent from what has been said here that this kind of affiliation of matter theory to ideology will not do. There are broadly similar claims made by a number of other historians. Carolyn Merchant, The death of nature: Women, ecology and the Scientific Revolution (San Francisco, 1980), for example, wishes to argue that the magical world view, occultism and a vitalistic belief in active matter can be associated, historically, with naturalistic, ecological and even feminine ideals, while the mechanical philosophy insisted upon dead, passive matter and was exploitative, aggressive, antithetical to the concept of nature and anti-feminist. For similar claims see David Kubrin, Newton’s inside out: Magic, class struggle, and the rise of mechanism in the West (in Harry Woolf (ed.), The analytic spirit: Essays in the history of science in honor of Henry Guerlac (Ithaca, 1981), 96-121; and Brian Easlea, Witchunting, magic and the New Philosophy: An introduction to debates of the Scientific Revolution, 1450-1750 (Hassocks, 1980). I believe that each of these writers and their theses have fallen victim to the prevailing mistaken historiography of pre-Newtonian matter theory (and like the victims of the vampire they then serve to propagate the same erroneous historiography).

81 Westfall, op. cit. (ref. 6), 324. Newton, op. cit. (ref. 12), 401. In using the word phenomenological I mean it only in its literal sense: the study of phenomena as opposed to the study of being. I do not intend it to convey all the philosophical baggage attached to the word by Husserl and his followers. It is important to note also that our natural philosophers were not phenomenologists: they did not believe that only phenomena are real. They believed in a reality underlying phenomena, knowledge of which could frequently be inferred (at least within certain limits laid down by their mitigated scepticism see ref. 99 below) from experimental investigation.

82 I. B. Cohen, The Principia, universal gravitation, and the Newtonian style in relation to the Newtonian Revolution in science (Bechler (ed.), op. cit. (ref. 44), 21-88; and idem, The Newtonian Revolution, with illustrations of the transformation of scientific ideas (Cambridge, 1980). The erudition and historical acumen of Professor Cohen together with the complexity and subtlety of his case go a long way to making these much more than hagiography. Nevertheless, I can help feeling they would be suitable candidates for analysis along the lines suggested in John A. Schuster, Methodologies as mythic structures: A preface to the future historiography of method (Metascience i (1984), 156-7).
83 Cohen, *The Principia and the Newtonian style* (ref. 82), 56, and see also 62; Isaac Newton, *Mathematical principles of natural philosophy and his system of the world*, translated by Andrew Motte in 1729 revised by Florian Cajori (Berkeley, 1960), 546–47. For further examples of Newton’s insistence that we know the properties of things from phenomena and related ideas (including the interesting remark: ‘I avoid hypotheses whether mechanical or of occult qualities’ see Hall and Hall (eds), op. cit. (ref. 11), 360–61 (Latin, 356), which is a draft for the General Scholium.

84 Glanvill, *Vanity of dogmatizing* (ref. 3), 210. Of course, the explanatory lacunae alsoprovide an ever-present guarantee that the mechanical philosophy cannot be commanded or used for atheistic purposes. My claim here, that the ascription of occult qualities in matter as an explanation of a given phenomenon will lead to further experimental investigation of the matter and the phenomenon, has recently been described as ‘what scientists actually do’ Harr, op. cit. (ref. 32), 90.


86 Glanvill, *Vanity of dogmatizing* (ref. 3), 202–204, p. 204.


88 Boyle, *Hydrostatical discourse*, Works (ref. 11), iii, 601; cf. 627.

89 Boyle, *New experiments physico-mechanical*, Works, i, 12.


93 Boyle, *Hidden qualities of the air*, Works (ref. 11), iv, 96, 88, 79.

94 Hutchison, op. cit. (ref. 32). In making his case Hutchison also shows how historians have misinterpreted the many attacks on occult qualities which were prevalent at this time. George MacDonald Ross, *Occultism and philosophy in the seventeenth century* in Holland (ed.), op. cit. (ref. 79), 95–105, makes a broadly similar point when he says that the new philosophers following the *Way of ideas* were even more dependent than the occultists on hidden or occult entities (p. 102).

95 I quote from the draft Newton sent to Cotes on 2 March 1712/13 which now forms part of the Newton-Cotes Correspondence (Trinity College Library, R.16.38). I have used the translations provided in I. B. Cohen, *Introduction to Newton’s Principia* (Cambridge, 1971), 241. Cohen discusses the various drafts of the scholium, pp. 240–45.

96 Letter from Leibniz to Conti, November/December 1715; draft of letter from Newton to Conti, 26 February 1715/16. These are quoted from and fully discussed in A. Koyre and I. B. Cohen, *Newton and the Leibniz-Clarke correspondence, with notes on Newton, Conti & Des Maizeaux*, Archives internationales d’histoire des sciences, xv (1962), 63–126, pp. 70 and 74; see also pp. 110 and 113 for drafts which make similar comments.

97 Newton, op. cit. (ref. 12), 401–402. The first of these extracts does not appear in the earlier editions of the *Opticks* (1704 and 1706 before Leibniz’s attack on occult qualities). See also Simon Schaffer, *Occultism and reason* in Holland (ed.), op. cit. (ref. 79), 117–123, pp. 136–139.

98I have discussed Holland, Petty, Glanvill and Hooke above; on Charleton see Hutchison, op. cit. (ref. 32), 245, where we are told that Charleton is attacking not occult qualities but the Aristotelians.

99 Christopher Wren Jr, *Parentalia: Or, memoirs of the family of the Wrens* but chiefly of Sir Christopher Wren in which is contained, besides his works, a great number of original papers and records (London, 1750), 221. See also J. A. Bennett, *A note on theories of respiration and muscular action in England*, c. 1660–1700, Medical History, xx (1976), 565–69.


102 Webster, op. cit. (ref. 23); Frank, op. cit. (ref. 25); Simon Schaffer, Bodily men and mechanical philosophers: Matter and spirit in English natural philosophy in the 1670s. Science in context, forthcoming. On Mayow and the elasticity of the air, see Frank, ibid., 262-263. See also A. G. Debus, Chemistry and the quest for a material spirit of life in the seventeenth century. In M. Fattori and M. Bianchi (eds), Spiritus: IVo Colloquia Internazionale del LESSICO Intelllettuale Europeo (Rome, 1984), 245-263.

103 Consider Boyle, Usefulness of experimental natural philosophy. Works (ref. 11), ii, 45; or Certain physiological essays, Works, i, 355-356; and the secondary sources cited in ref. 29. The ideological uses of mitigated scepticism were, of course, first chronicled in R. H. Popkin’s history of scepticism (1960), now revised as A history of scepticism from Erasmus to Spinoza (Berkeley, 1979); but see also Barbara J. Shapiro, Probability and certainty in seventeenth-century England (Princeton, 1983). I have given indications of the response to the dogmatic use of the mechanical philosophy to promote counter-reforming Catholic theology in John Henry, Atomism and eschatology: Catholicism and natural philosophy in the Interregnum. The British Journal for the History of Science, xv (1982), 211-219, especially pp. 237-239. For the response to enthusiastic natural philosophy see P. M. Rattansi, op. cit. (ref. 19). Although I am critical of Rattansi’s paper in ref. 19 above, I fully accept his claim that various Paracelsian/Helmontian world views were associated by contemporaries with subversive enthusiasm in religion. My point is merely that he is mistaken in seeing this as a factor leading to the rejection of concepts of active matter. Owen Hannaway in his study of an earlier debate about Paracelsian philosophy has quite clearly shown that it is possible for a thinker to reject Paracelsian enthusiasm while still accepting Paracelsian active principles in matter; Hannaway, op. cit. (ref. 23), 84-90, 99 and passim.

104 Paul Wood, Methodology and apologetics: Thomas Sprat. History of the Royal Society (The British Journal for the History of Science, xiii (1980), 125; idem, Francis Bacon and the Experimental philosophy. A study in seventeenth-century methodology (M. Phil. thesis, University of London, 1978); Steven Shapin, The lamp and circumstance: Robert Boyle’s literary technology. Social Studies of Science, xiv (1984), 481-500; Steven Shapin and Simon Schaffer, Leviathan and the Air-Pump: Hobbes, Boyle and the experimental life (Princeton, 1985); and Peter Dear, Opera: Rhetoric and authority in the early Royal Society (1st ed.) (1985), 145-146. Laudan, op. cit. (ref. 32) has argued that Descartes too was a mitigated sceptic, but for a corrective to this view see G. A. J. Rogers, Descartes and the method of English science. Annals of science, xxii (1966), 73-104. I would go further than Rogers and argue that Descartes was frequently regarded, particularly by theologians, as a dogmatist. For example see Meric Casaubon, On learning (1667), reprinted in M. R. G. Spiller, Concerning natural experimental philosophy. Meric Casaubon and the Royal Society (The Hague, 1980), 195-214, p. 203; and Edward Stillwell, op. cit. (ref. 35), ii, 101. It is even possible for a modern scholar, unconcerned about the subversive implications of Cartesianism, to claim that Descartes was firmly in the camp of occultist enthusiasts. See G. MacDonald Ross, op. cit. (ref. 94), 113, note 54; also note 56.

105 On the importance of this tradition to the development of science see the works by McGuire and Oakley cited in ref. 67; Hooykaas, op. cit. (ref. 63); Margaret J. Osier, Descartes and Charleton on Nature and God. Journal of the history of ideas, xl (1979), 445-456; Eugene M. Klaaren, Religious origins of modern science: Belief in creation in seventeenth-century thought (Grand Rapids, 1977), 296. Oakley, Christian theology and the Newtonian science. Ibid., 442. Unfortunately there are exceptions to this rule. Descartes and Hobbes both managed to combine voluntarism with rationalism. This needs to be explained. R. Hooykaas, op. cit. (ref. 63) noted merely that Descartes’s combination of voluntarism and rationalism was strange (p. 41) and paradoxical (p. 42) but he made no
attempt to account for it. Margaret Osler argues that Descartes is a modified necessitarian (necessitarianism being the theological position opposed to voluntarism) but I find this unconvincing. As far as I know there is no study of Hobbes's voluntarism but see J. Bamouw, "The separation of reason and faith in Bacon and Hobbes and Leibniz's Theodicy." Journal of the History of Ideas, xlii (1981), 607-628, pp. 616-619. These are serious lacunae in our understanding of seventeenth century natural philosophy. Nevertheless, irrespective of Descartes and Hobbes's attitudes, we can safely say that the majority of voluntarist mechanical philosophers professed themselves to be empiricist, and argued that their view of God and his relationship to the world was only compatible with empiricism.

380 106 Locke, op. cit. (ref. 79), IV, iii, 6.

107 Glisson, De natura substantiae energetica (ref. 23), sig. A5r. Let two examples of Boyle's rejection of sense and appetite of matter suffice: High veneration to God (1685), Works (ref. 11), v, 141; and Notion of Nature, Works, v, 222. Ralph Cudworth, "The true intellectual system of the universe (London, 1678), 105; Henry More, Opera omnia (2 vols, London, 1679), i, 604ff. More's and Cudworth's attacks on Glisson are discussed in Henry, op. cit. (ref. 23). More's empiricism and his opposition to Boyle's voluntarism are discussed in Henry, op. cit. (ref. 70). On Cudworth's empiricism see Oakley, "Christian theology and the Newtonian science" (ref. 67), 441; Richard Baxter, "Of the immortality of Mans Soule, and the nature of it, and other spirits" (London, 1682), 284ff. 108 Oakley, Omnipotence, covenant, & order (ref. 67), 114; Steven Shapin, "Of Gods and Kings" Natural philosophy and politics in the Leibniz-Clarke disputes (1871), p. 192.

109 Cohen (ed.), op. cit. (ref. 28), 185. I have yet to come across a natural philosopher in England who was not a voluntarist.


111 See, for example, E. G. Ruestow, Physics at seventeenth and eighteenth century Leiden (The Hague, 1973); or compare L. W. B. Brockliss, "Aristotle, Descartes and the New Science: Natural philosophy at the University of Paris, 1600-1740" Annals of Science, xxxviii (1981), 33ff; with R. G. Frank Jr, Science, medicine and the universities of early modern England: Background and sources (History of Science, xi (1973), 194ff, 239ff. Consider also David Hume's puzzlement in 1748: I must confess, that there is something in the fate of opinions a little extraordinary. Des Cartes insinuated that doctrine of the universal and sole efficacy of the Deity without insisting on it. Malebranche and other Cartesian made it the foundation of all their philosophy. It had, however, no authority in England. Locke, Clarke and Cudworth, never so much as take notice of it, but suppose all along that matter has a real, though subordinate and derived power. By what means has it become so prevalent among our modern metaphysicians? Hume, op. cit. (ref. 3), VIII, i, 57, in the footnote.


381 113 Westfall, Newton and the Hermetic tradition (ref. 7), 187. Hermeticism is currently out of vogue largely as a result of Westman and McGuire, op. cit. (ref. 7); and C. B. Schmitt, "Reappraisals in Renaissance science" History of Science, xvi (1978), 200ff. For further surveys which suggest that Descartes was forced to smuggle activity into his system see Prendergast, op. cit. (ref. 5); and Hatfield, op. cit. (ref. 5).

114 Westfall, Newton and the Hermetic tradition (ref. 7), 187.

115 For the latter see refs 6 and 7 above. For the former consider Rene Dugas, Mechanics in the seventeenth century (Paris, 1958); John W. Herivel, The background to Newton's Principia (Oxford, 1965); developments in dynamics are also the major focus of Westfall, op. cit. (ref. 28); and Gabbney, op. cit. (ref. 5), and Cohen, op. cit. (ref. 82). See also D. T. Whiteside, "The mathematical principles underlying Newton's Principia mat hematica" Journal for the history of astronomy, i (1970), 116ff; and idem, Newton the mathematician (In Bechler (ed.), op. cit. (ref. 44), 109ff.

116 Newton, op. cit. (ref. 12), 401.

117 Once again the reader is referred to the spirited promotion of just this methodological approach in Harr□□op. cit. (ref. 32).

Short titles in the notes to this paper refer to the following:


Richard Baxter, Of the Immortality of Man’s Soul, and the Nature of it and Other Spirits, London, 1682.


Joseph Glanvill, Saducismus Triumphantus, or Full and plain Evidence Concerning Witches and Apparitions. London, 1681.


Henry More, Remarks upon Two Late Ingenious Discourses (by Sir Matthew Hale), so far forth as they may concern any passages in his Enchiridion Metaphysicum. London, 1676.


Samuel Parker, A Free and Impartial Censure of the PlatonickPhilosophie, Oxford, 1667.


George Rust, A Discourse of the Use of Reason in Matters of Religion, London, 1683.


Robert Hooke, the Incongruous Mechanist


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2 William Blake, Jerusalem: The emanation of the giant Albion (1804), Plate 15, lines 152; see Donald D. Ault, Visionary physics: Blake’s response to Newton (Chicago, 1974).
3 John Keats, Lamia (1820), Part II, lines 229-37. On Keats’ location in Enlightenment science, see Donald C. Goellnicht, The poet-physician: Keats and medical science (Pittsburgh, 1984).
6 Alan E. Shapiro, in his Artists’Colours and Newton’sColours (s), lxxxv (1994), 600B30, suggests that Newton discovered that white light was made of an infinite number of spectral colours (p. 600). This is just loose talk, however, written in the light of our knowledge of the electromagnetic spectrum. Newton himself clearly believed that there were only seven primary colours.
7 Isaac Newton, Opticks, based on the fourth edition London, 1730 (New York, 1952), Bk I, Pt II, Prop. III, Problem I, 126, my emphasis. The ellipses indicate where I have omitted Newton’s 36 labelling of the lines in accordance with his accompanying diagram.
9Newton had shown, by further prismatic experiments, that the colours of the spectrum could not themselves be broken into further colours. Repeated refractions merely separated the colours further apart, but did not alter their colours. Opticks, Bk I, Pt I, Prop. V, Theorem IV, ed. cit. (ref. 7), 73-75.

10See, for example, A. I. Sabra, Theories of light from Descartes to Newton (Cambridge, 1981).

11The optical papers of Isaac Newton, ed. by Alan E. Shapiro (Cambridge, 1984), 543. Newton defended this musical analogy in a letter to an Oxford undergraduate, John Harrington, in May 1698, where he wrote: I am inclined to believe some general laws of the Creator prevailed with respect to the agreeable or unpleasing affections of all our senses. Newton, Correspondence, ed. by H. W. Turnbull et al. (7 vols, Cambridge, 1959–77), iv, 275, quoted by Shapiro, ed. cit., 547.


17Examples of this approach can be seen in a number of papers in M. L. Rhigini Bonelli and W. R. Shea (eds), Reason, experiment, and mysticism in the Scientific Revolution (London, 1975), particularly: Paolo Casini, Newton, a sceptical alchemist? A. Rupert Hall, Magic, metaphysics and mysticism in the Scientific Revolution; and perhaps even Paolo Rossi, Hermeticism, rationality and the Scientific Revolution. But see also Bronislaw Malinowsld, Magic, science and religion and other essays (Boston,

18It is important to exonerate Brian Vickers from these charges. Professor Vickers’s extensive, careful and thoughtful scholarship has done much to increase our understanding of the history of magic. Even so, I have to say that I find his distinction between two mentalities—occult and scientific, in the pre-modern period, is a clear case of putting the positivist cart before the historical horse. See his Introduction to Vickers (ed.), *Occult and scientific mentalities in the Renaissance* (ref. 14), 1-5.


20The denials are based on a misreading of a single comment by Newton in a letter to Richard Bentley written in February 1693. Although this comment, on a superficial glance, might look like a denial of action at a distance, it is not. The misreading was pointed out long ago by Emile Meyerson, *Leibniz, Newton, and action at a distance* in idem, *Identity and reality* (London, 1930), 447-56; and reiterated more recently in John Henry, *Pray do not ascribe that notion to me*: God and Newton’s gravity* in James E. 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, 1994), 123-47. For the quotation in question, see Cohen (ed.), *Isaac Newton’s papers and letters on natural philosophy* (ref. 8), 302.


38 23 I have argued this elsewhere: John Henry, *Magic and science in the sixteenth and seventeenth centuries* in G. N. Cantor, J. R. R. Christie, J. Hodge, and R. C. Olby (eds), *Companion to the history of modern science* (London and New York, 1990), 583-596; and The Scientific Revolution and the origins of modern science, 2nd edn (Basingstoke and New York, 2002), 547-57. See also Rossi, *Francis Bacon* (ref. 15); and Webster, From Paracelsus to Newton (ref. 15). See also Ann Blair, *Natural philosophy* in Katharine Park and Lorraine Dowd (eds), The Cambridge history of science, Early modern science (Cambridge, 2006), 365-366, who writes of the transformation of natural philosophy by empirical and mathematical methods, but does not explicitly mention the magical tradition as a source of these methods.


26I am encouraged in this line of argument by the similar claim made brilliantly with regard to alchemy in Lawrence M. Principe and William R. Newman, *Some problems with the historiography of alchemy* in W. R. Newman and A. Grafton (eds), *Secrets of nature:

27 For a discussion of the clear separation, and distance, between two major aspects of what we might think of as a unified magical tradition, astrology and alchemy, see Newman and Grafton (eds), Secrets of nature (ref. 26), 14–27.


29 Giambattista della Porta, Natural magick in twenty books (London, 1658), Bk I, chap. 2, p. 2. This popular manual of natural magic was originally published in four books in Naples, 1554, and in twenty books in 1589. For a brief discussion, see Millen, Manifestation of occult qualities (ref. 15).

30 Cornelius Agrippa, De incertitudine et vanitate omnium scientiarum et artium (n.p., 1531), chap. 42.

31 Francis Bacon, Novum organum, Pt I, Aphorism IV. On magic in the work of Francis Bacon see Rossi, Francis Bacon (ref. 15); and John Henry, Knowledge is power: Francis Bacon and the method of science (Cambridge, 2002), 42–61.


33 Women and, to a lesser extent, uneducated men were held to be capable of magical knowledge, of course, but usually only to a limited extent. Prejudiced assumptions by the elite about the limits of the knowledge of such cunning men and women were to have appalling consequences during the witch crazes. Supposed success in magical operations was assumed to have been achieved thanks to the Devil’s help (rather than by knowledge of natural occult qualities and powers), and so the witch was presumed guilty of commerce with Satan. The educated magus would always have been able to defend himself from similar charges by insisting that he used only natural magic, and by demonstrating a clear understanding of the distinction between natural and demonic magic. Uneducated witches were not always able to make such clear distinctions, and much less so during inquisitorial proceedings. On popular knowledge of medicine see John Henry, Doctors and healers: Popular culture and the medical profession in Stephen Pumfrey, Paolo Rossi, and Maurice Slavinski (eds), Science, culture and popular belief in Renaissance Europe (Manchester, 1991), 191–221. Literature on the witch crazes is vastly extensive, but see, for example, Norman Cohn, Europe’s inner demons: The demonization of Christians in medieval Christendom (Chicago, 1993); Hugh Trevor-Roper, The European witch-craze of the sixteenth and seventeenth centuries (Harmondsworth, 1969); and Bengt Ankarloo, Stuart Clark, and William Monter (eds), Witchcraft and magic in Europe: The period of the witch trials (Philadelphia, 2002).

34 Agrippa, De incertitudine et vanitate omnium scientiarum (ref. 30), chap. 42. See also Lauren Kassel, was that land full fill of faerie magic and the past in early modern England Journal of the history of ideas, lxvii (2006), 107–22, p. 112.


36 Recorded during one of the weekly conferences conducted at Theophraste Renaudot’s Bureau d’Adresse from 1633 to 1642. Quoted from Kathleen Wellman, Talismans, incubi, divination and the Book of M*: The Bureau d’Adresse confronts the occult in A. G. Debus and Michael T. Walton (eds), Reading the book of nature: The other side of the Scientific Revolution (St Louis, 1998), 215–28, p. 228.


38 Clark, Scientific status of demonology (ref. 28); and idem, Thinking with demons (ref. 28), 161–78.

39 John Cotta, The triall of witch-craft (London, 1616), 34.

40 William Perkins, Discourse of the damned art of witch-craft (Cambridge, 1610), 59. The fact that Perkins does not list magicians among those that are most excellent in the knowledge of natural magic reflects the Church’s reluctance to acknowledge anything worthy in magicians (Perkins was an Anglican clergyman). This is discussed more fully below.
41 James VI, Daemonologie (Edinburgh, 1597), 44.
42 The most notorious example of this kind of short cut to wisdom is provided by John Dee, who thanks to his divining stone and a supposedly psychic medium, Edward Kelly, who was all too willing to please, held many conversations with angels from 1582 to 1587, with a view to being able to make the philosopher’s stone. Note that Dee, for obvious religious reasons, always claimed he was summoning angels, not demons. See Deborah E. Harkness, John Dee’s conversations with angels: Cabala, alchemy, and the end of nature (Cambridge, 1999).
43 Perkins, Discourse of the damned art of witchcraft (ref. 40), 20.
44 Agrippa, De incertitudine et vanitate omnium scientiarum (ref. 30), chap. 42.
46 See D. P. Walker, Spiritual and demonic magic from Ficino to Campanella (London, 1958), 36, 83; and Hansen, The honourable histories of Frier Bacon and Frier Bungay (c. 1592). On the legend of Faust, see E. M. Butler, The myth of the magus, Ritual magic, and The fortunes of Faust (Cambridge, 1948, 1949, and 1952). Literature on the witch-crazes is vast and extensive, but see, for example, the works cited in ref. 33 above.
47 Or some who were more than one of these things, magical traditions featured prominently in Renaissance eclecticism. John Napier, for example, inventor of logarithms, also devoted much of his time to alchemy, and was known locally, in Edinburgh, as a wizard. See Francis Shennan, Flesh and bones: The life, passions and legacies of John Napier (Edinburgh, 1989).
49 For a recent discussion of Naudes book see Kassell, op. cit. (ref. 34); and Molland, Roger Bacon as magician (ref. 48), 448.
51 On Bacon’s criticisms of magic see Rossi, Francis Bacon (ref. 15), 31-35.
52 The retraction appeared in a general attack on all human knowledge, and an affirmation of Christian fideism, Cornelius Agrippa, De incertitudine et vanitate scientiarum declamatio invectiva (n.p., 1530), but has been shown to share the same magico-religious foundations as the De occulta philosophia so much so that the two works are said to share a basic unity. See Michael H. Keefer, Agrippa’s dilemena: Hermetic rebirth and the ambivalence of De vanitate and De occulta philosophia (Renaissance quarterly, xli (1988), 614-63.
53. Newton, Opticks (ref. 7), Bk III, Pt I, Query 31, p. 401.
54 For example, Optics (ref. 7), Queries, 1, 4, 21, 29, and 31, pp. 339, 352, 371, 375 et Isaac Newton, he Principia: Mathematical principles of natural philosophy, a new transl. by I. B. Cohen and Anne Whitman (Berkeley, 1999), 382-383. On Newton’s alchemy see the works cited in ref. 15 above. On action at a distance in Newton see Henry, I pray do not ascribe that notion to me (ref. 20).
55 On the sociology of boundary demarcation see the works cited in ref. 25 above. We have mentioned the continuing and constant religious objection to demonology, but there was a new development in the late Renaissance and early modern periods, namely a sceptical denial of the existence of demons and other spiritual beings that went hand-in-hand with the rise of atheism, irreligion and secularism. For a general survey of such trends see Richard H. Popkin, The history of scepticism from Erasmus to Spinoza (Berkeley, 1979). For the relevance of these developments to the decline of magic, especially demonology, see Michael Hunter, Witchcraft and the decline of belief (Eighteenth-century life, xxii (1998), 139-147.
56. See Vickers, Introduction in idem (ed.), Occult and scientific mentalities (ref. 14), 155. Professor Vickers is more sophisticated than the label positivist might imply. In a recent essay he has distinguished between occult, a neutral distinction between visible and invisible causes, and occult, which is not so clearly defined (he refers to it as a synthesis of magic and astrology, a philosophy in its own right, and an aggressive formulation which led to an increasingly bitter denunciation of occultism by both the Church and secular scholars). I can agree that in the process of redefining boundaries there was this kind of bifurcation of the occult, but I see it as a process hinging upon many historical contingencies, while Professor Vickers seems to see it merely as a matter of an ahistorical entity called science, trumping over an ahistorical entity called magic. See Brian Vickers, The occult in the Renaissance, Annals of science, iii (1995), 770.


58 Literature on the relations between the new philosophies and religion is vast, but for recent provocative insights see Amos Funkenstein, Theology and the scientific imagination from the Middle Ages to the seventeenth century (Princeton, 1986); Peter Harrison, The Bible, Protestantism, and the rise of natural science (Cambridge, 1998); and Stephen Gaukroger, The emergence of a scientific culture: Science and the shaping of modernity, 1250-1685 (Oxford, 2006).

59 In fact there was a short-lived attempt to do just this, and this will be briefly discussed later (see ref. 110 and text at that point). But this was a minor historical episode that serves to highlight the more general trend.

60 Stuart Clark, The rational witchfinder: Conscience, demonological naturalism and popular superstitions in Pumfrey, Rossi and Slawinski (eds), Science, culture and popular belief (ref. 33), 222; and idem, Thinking with demons (ref. 28).

61 Stuart Clark, Rational witchfinder (ref. 60); and Bert Hansen, Science and magic (ref. 35), 488. See also Caroline Oates, Metamorphosis and lycanthropy in Franche-Comté in M. Feher (ed.), Fragments for a history of the human body, Part One (New York, 1989), 305, especially p. 320.

62 Stuart Clark, Rational witchfinder (ref. 60).

63 Ibid.

64 Literature on the witch-crazes is dauntingly vast, but see, for example, Christina Lamer, Witchcraft and religion: The politics of popular belief (Oxford, 1984); Joseph Klaitz, Servants of Satan: The age of the witch hunts (Bloomington, 1985); Jonathan Barry, Marianne Hester and Gareth Roberts (eds), Witchcraft in early modern Europe: Studies in culture and belief (Cambridge, 1996); Robin Briggs, Witches and neighbours: The social and cultural context of European witchcraft (London, 1996); and the works cited in ref. 33 above.


66 See Hunter Michael, Boyle by himself (ref. 65), 29.  

67 Quoted from Michael Hunter, Alchemy, magic and moralism (ref. 65), 116.

68 For detailed expositions of what has come to be called the scholar and craftsman thesis, see Edgar Zilsel, The social origins of modern science (Dordrecht, 2000); Pamela H. Smith, The body of the artisan: Art and experience in the Scientific Revolution (Chicago, 2004); and idem, Laboratories in Katharine Park and Lorraine Daston (eds), Cambridge history of science, iii (ref. 23), 290-319.


73 See Thorndike, History of Magic and Experimental Science (ref. 45); M. Sherwood, Magic and mechanics in medieval fiction, Studies in Philology, xli (1947), 567–62; Zetterberg, The mistaking of the mathematicicks for magic (ref. 72); William Eamon, Technology as magic in the late Middle Ages and the Renaissance, 1983, 171; A. George Molland, Cornelius Agrippa’s mathematical magic, in Cynthia Hay (ed.), Mathematics from manuscript to print (Oxford, 1988), 209–19; and John Henry, Magic and science (ref. 23).


75 Zetterberg, The mistaking of the mathematicics for magic (ref. 72). For more positivist tendencies in the history of Renaissance mathematics see Edward W. Strong, Procedures and metaphysics: A study in the philosophy of mathematical-physical science in the sixteenth and seventeenth centuries (Berkeley, 1936).


77 John Wilkins, Mathematical magick, or; the wonders that may be performed by mechanical geometry (London, 1648). The major study is still Barbara Shapiro, John Wilkins: An intellectual biography (Berkeley, 1969), but see also Ana Maria Alfonso-Goldfarb, An older view about matter in John Wilkins’ modern mathematical magick, in Debus and Walton (eds), Reading the book of nature (ref. 36), 133–46.

78 René Descartes, Principia philosophiae, IV, 203. On the impact of the pseudo-Aristotelian Quaestiones mechanicae, see Helen Hattab, From mechanics to mechanism: The Quaestiones mechanicae and Descartes’ physics, in Peter R. Anstey and John A. Schuster (eds), The science of nature in the seventeenth century: Patterns of change in early modern natural philosophy (Dordrecht, 2005), 99–129.

79 This book has been translated into English: Girolamo Cardano, De substitutio, Book I, translated, with introduction and notes, by Myrtle Marguerite Cass (Williamsport, PA, 1934). The best edition of the De substitutio (currently only the first seven books) is De substitutio libri XXI (Libri VII), ed. by Elio Nenci (Milan, 2004). For studies of Cardano see Angelo Bellini, Girolamo Cardano 315e ii suo tempo (Milan, 1947); Nancy G. Siraisi, The clock and the mirror: Girolamo Cardano and Renaissance medicine (Princeton, 1997); and Anthony Grafton, Cardano’s Cosmos: The worlds and works of a Renaissance astrologer (Cambridge, MA, 1999). See also Girolamo Cardano, De libris propriis: The editions of 1544, 1550, 1557, 1562, ed. by Ian Maclean (Milan, 2004).

80 Jens flyrup, Philosophy: Accident, epiphenomenon, or contributory cause of the changing trends of mathematics? A sketch of the development from the twelfth through the sixteenth century, in idem, In measure, number, and weight: Studies in mathematics and culture (Albany, 1994), 123–71, p. 165, see also pp. 154–66. See also William R. Newman,
Promethean ambitions: Alchemy and the quest to perfect nature (Chicago, 2004).

81See McGuire and Rattansi, Newton and the Pipes of Pan (ref. 12). Consider also, in this connection, Ayval Leshem, Newton on mathematics and spiritual purity (Dordrecht, 2003).


85 Ibid., 386. See also W. R. Newman and L. M. Principe, Alchemy vs. chemistry: The etymological origins of a historiographic mistake (Early science and medicine, iii (1998), 326–327).

86 Principe and Newman, Some problems with the historiography of alchemy (ref. 26), 418.

87 Ibid., 413–415. The principle contributor to this new scholarship is William Newman himself. See, for a recent example, Newman, Atoms and alchemy (ref. 16).

88 William B. Ashworth Jr, Natural history and the emblematic world view (Cambridge, 1980), 303–305. See also James J. Bono, The word of God and the languages of man: Interpreting nature in early modern science and medicine (Madison, 1995); and Harrison, The Bible, Protestantism, and the rise of natural science (ref. 58). But see also Ann Blair, Historia in Zwinger’s The atrum humanae vitae (Gianna Pomata and Nancy G. Siraisi (eds), Historia: Empiricism and erudition in early modern Europe (Cambridge, MA, 2005), 269–286.

89 On these new occultist developments in medicine see Linda Deer Richardson, The generation of disease: Occult causes and diseases of the total substance (Cambridge, 1985), 175–176; and John Henry and John M. Forrester, Jean Fernel and the importance of his De abditis rerum causis in idem, Jean Fernel’s On the hidden causes of things: Forms, souls and occult diseases in Renaissance medicine (Leiden, 2005), 375–376.

90 Jean Fernel, De abditis rerum causis (Paris, 1648), Bk II, chap. 16. For a new edition and translation of this important work see Forrester and Henry, Jean Fernel’s On the hidden causes of things (ref. 89); on amulets, see pp. 464–473.

91. Johann Wier, Depraestigiis daemonum (Basel, 1583), Bk V, chap. 8, column 535, quoted from Walker, Spiritual and demonic magic (ref. 46), 154; and, of course, Genesis, 1, 3.

92 See Hansen, Science and magic (ref. 35), 488.


Enlightenment (Dordrecht, 1991), 83□□□99; and Rossi , Logic and the art of memory (ref. 93). 96. Guy de la Brosse (1628) and John Ray (1660), both quoted from Brian Vickers , Critical reactions to the occult sciences during the Renaissance in E. Ullmann-Margalit (ed.), The scientific enterprise (Dordrecht, 1992), 43□□□99, pp. 77□□□99.

For a recent convenient summary of the Renaissance arguments against astrology, see Vickers , Critical reactions to the occult sciences during the Renaissance (ref. 96). But see also, Jim Tester , A history of Western astrology (Woodbridge, 1987); Eugenio Garin , Astrology in the Renaissance: The zodiac of life (London, 1983); and H. Darrel Rutldn , Astrology, in Park and Daston (eds), The Cambridge history of science, iii (ref. 23), 542□□□561.

97For a recent convenient summary of the Renaissance arguments against astrology, see Vickers , Critical reactions to the occult sciences during the Renaissance (ref. 96). But see also, Jim Tester , A history of Western astrology (Woodbridge, 1987); Eugenio Garin , Astrology in the Renaissance: The zodiac of life (London, 1983); and H. Darrel Rutldn , Astrology, in Park and Daston (eds), The Cambridge history of science, iii (ref. 23), 542□□□561.

98. Johannes Kepler , Mysterium cosmographicum (1597), in Gesammelte Werke, i (Munich, 1938), 21. Galileo, always loath to accept magical influence, did deny the effect of the Moon on the tides. On this issue, however, the magicians were correct and Galileo was embarrassingly wrong. Galileo Galilei , Dialogue on the two chief world systems, transl. by Stillman Drake (New York, 2001), Fourth Day, 487.

99See J. V. Field , Astrology in Kepler’s cosmology , in Patrick Curry (ed.), Astrology, science and society (Woodbridge, 1987), 143□□□92; and idem, A Lutheran astrologer: Johannes Kepler, Archive for history of exact sciences, xxxi (1984), 189□□□272 (which includes a complete translation of De fundamentis astrologiae certioribus).

100 Vickers , Critical reactions to the occult sciences (ref. 96); and Tester , A history of Western astrology (ref. 97).


103 Edmund Halley , Some considerations about the cause of the universal deluge Philosophical transactions, xxxiii (1724), 118□□□55; and William Whiston , Vindication of the new theory of the Earth (London, 1698), Preface; both quoted from Schaffer , Newton’s comets (ref. 103), 233.

45 104Newton’s belief recorded by his friend John Craig, Cambridge University Library, Keynes MS 130.7.f. 1r. See also Isaac Newton , De gravitatione et aequipondio fluidorum in A. R. Hall and M. B. Hall (eds), Unpublished scientific papers of Isaac Newton (Cambridge, 1962), 139.

105The rivalry on this issue between Newton and Leibniz is brought out most starkly in the so-called Leibniz-Clarke correspondence. See H. G. Alexander (ed.), The Leibniz-Clarke correspondence (Manchester, 1956); and Ezio Vailati , Leibniz and Clarke: A study of their correspondence (Oxford, 1997). For an account of the role of comets in Newton’s system, see David Kubrin , Newton and the cyclical cosmos Journal of the history of ideas, xxviii (1967), 325□□□46; Sara Schechner Genthal , Comets, teleology and the relationship of chemistry to cosmology in Newton’s thought, Annali dell’Istituto e Museo di Storia della Scienza di Firenze, x (1985), 51□□□65; and Schaffer , Newton’s comets (ref. 103).

106Two developments summed up by Pierre Simon Laplace , author of Traité de mécanique céleste (5 vols, 1799□□□925), who used Newtonian mechanics to show that the planetary system was self-regulating, without the need for comets, and who also told Napoleon that God was not mentioned in his book because he had no need of that hypothesis See C. C. Gillispie , Pierre-Simon Laplace, 1749□□□97: A life in exact science (Princeton, 1997).


108. J. A. Bennett , Magnetic philosophy and astronomy from Wilkins to Hooke, in R. Taton and C. Wilson (eds), Planetary astronomy from the Renaissance to the rise of astrophysics, Part A: Tycho Brahe to Newton (Cambridge, 1989), 22□□□0. On Kepler’s use
of Gilbert see, for example, Koyrinos The astronomical revolution (ref.82), 185ff.


111It is like comparing Wilkins, Mathematical magick (ref. 77), with, say, Petrus Severinus, Idea medicinae philosophicae: Fundamenta continens totius doctrinae Paracelsicae, Hippocraticae, & Galenicae (Basel, 1571).

112But remember what was said earlier about the possibility that the work of other numerologists on the Keplerian or Newtonian model might simply be being overlooked.

113The main support for the claim that experimentalism and the utilitarianism of the new philosophies derives from the occult tradition is to be found in Francis Bacon. See Rossi, Francis Bacon: From magic to science (ref. 15); and Henry, Knowledge is power (ref. 31). But see also, for example, Henry, Magic and science (ref. 23); idem, Occult qualities and the experimental philosophy (ref. 15); and idem, Animism and empiricism (ref. 70).

46 114On the decline of belief in symbolic magic, see Brian Vickers, Analogy versus identity: The rejection of occult symbolism, 15801680 in idem (ed.), Occult and scientific mentalities (ref. 14); and idem, Critical reactions to the occult sciences (ref. 96). See also, Brian Copenhaver, The occultist tradition and its critics in D. Garber and M. Ayers (eds), The Cambridge history of seventeenth-century philosophy (Cambridge, 1998), 445ff.

115 Walker, Spiritual and demonic magic (ref. 46), 84; Thomas, Religion and the decline of magic (ref. 24); and Clark, The rational witchfinder (ref. 60).

116. The literature here is vast but an obvious starting point is Thomas, Religion and the decline of magic (ref. 24). Consider also Clark, Thinking with demons (ref. 28). On the socio-political dimensions of alchemy, which has been well served in the literature, see for example P. M. Rattansi, Paracelsus and the Puritan revolutionAmbix, xi (1963), 243ff; Hugh Trevor-Roper, The Paracelsian movement in idem, Renaissance essays (London, 1985), 149ff; J. Andrew Mendelsohn, Alchemy and politics in England Past and present, cxxxv (1992), 30ff; and William Newman, From alchemy to chymistry in Park and Daston (eds), The Cambridge history of science, iii (ref. 23), 497ff. On the political dimension to astrology, see for example, Patrick Curry, Prophecy and power: Astrology in early modern England (Oxford, 1989). See also, for another example, Paola Zambelli, Magic and radical reformation in Agrippa of NettesheimJournal of the Warburg and Courtauld Institutes, xxxix (1976), 69ff.

117. Consider, for example, Thomas Digges, A perfid description of the caeliestall orbes, according to the most auncient doctrine of the Pythagoreans (London, 1576). On this tradition, usually called the prisca theologia tradition, consult Charles B. Schmitt, Prisca theologia e philosophia perennis: Due temi del Rinascimento italiano e la loro fortuna in Atti del V Convegno Internazionale del Centro di Studi Umanistici: Il pensiero italiano del Rinascimento e il tempo nostro (Florence, 1970), 211ff; and D. P. Walker, The ancient theology: Studies in Christian Platonism from the fifteenth to the eighteenth century (London, 1972).

118.De vita coelitus comparanda was the third part of FicinoDe vita triplici (Florence 1489). The meaning of the title is obscure, possibly something like: On arranging oneelife in accordance with the heavensSee Walker, Spiritual and demonic magic (ref. 46), 58, where Walker makes it clear that spiritual magic is his own phrase to describe Ficinos ideas. For an indication of Ficinos immense influence see, for example, Hiro Hirai, Le concept de sentence dans les theories de la matiere en Renaissance: De Marsile Ficino a Pierre Gasendi (Tumhout, 2005).

119See Eugenio Garin, The philosopher and the magus in idem (ed.), Renaissance characters, transl. by Lydia G. Cochrane (Chicago, 1997), 123ff. See also Borchardt, The magus as Renaissance man (ref. 57). We should also remember, however, that even a highly learned magician such as Agrippa might call himself a magus and at the same time be anxious about the religious implications of being a magus. See Keefer, Agrippa dilemma (ref. 52).
120. The most convenient source on the religious Corpus Hermeticum, which includes an
invaluable introduction, is Brian P. Copenhaver, Hermetica: The Greek Corpus
Hermeticum and the Latin Asclepius in English translation (Cambridge, 1991). On the so-
called technical writings see A.-J. Festugiere, La revelation d'Hermes Trismестиaste, L'Astrologie et
les sciences occultes (Paris, 1950). For brief assessments of the historical significance of
the Hermetic writings see Copenhaver, Astrology and magic (ref. 15); idem, Natural
magic, Hermeticism, and occultism in early modern science (ref. 15); and idem, Magic in
Park and Daston (eds), Cambridge history of science, iii (ref. 23), 518ff.
121 Copenhaver, Astrology and magic (ref. 15); idem, Did science have a Renaissance? (ref. 37); and Walker, Spiritual and demonic magic (ref. 46).
122 Copenhaver, Astrology and magic (ref. 15), 273.
123 For an important study of the role of discussions of natural powers and the abilities of
demons, see Newman, Promethean ambitions (ref. 80).
47 124 On Paracelsus see, for example, Walter Pagel, Paracelsus: An introduction to
philosophical medicine 319 in the era of the Renaissance (Basel, 1958); and A. Weeks, 
Fracastoro, see Vivian Nutton, The seeds of disease: An explanation of contagion and
infection from the Greeks to the Renaissance (Medical history, xxvii (1983), 184; and idem, The reception of Fracastoros theory of contagion: The seed that fell among thorns? Osiris, n.s, vi (1990), 196ff. On Fermi, see Richardson, Generation of disease (ref. 89); 
Laurence Brockliss and Colin Jones, The medical world of early modern France (Oxford, 1997); Hiroshi Hirai, Humanisme, neoplatonisme et priscia theologia dans le concept de
semece de Jean Fernel (Corpus, xii (2002), 43ff; D. P. Walker, The astral body in
Renaissance medicine (Journal of the Warburg and Courtauld Institutes, xxi (1958), 119ff; idem, Medical spirits in philosophy from Ficino to Newton (Arts du spectacle et
histoire des idees (Tours, 1984), 287ff; and Henry and Forrester, Jean Fernel and the
importance of his De abditis rerum causis (ref. 89).
125 For brief accounts of the nature of alchemy see Bruce T. Moran, Distilling knowledge:
Alchemy, chemistry, and the Scientific Revolution (Cambridge, 2005); Newman, Atoms and alchemy (ref. 16); and idem, From alchemy to chemistry (ref. 116). On occult qualities see Keith Hutchison, What happened to occult qualities in the Renaissance? Osiris, lxiii (1982), 233ff; and Millen, Manifestation of occult qualities (ref. 15).
126 Copenhaver, Astrology and magic (ref. 15).
127. On this aspect of Aristotelianism see, for example, Peter Dear, Discipline and experience (ref. 74), 11ff; and idem, The meanings of experience in Park and Daston (eds), Cambridge history of science, iii (ref. 23), 106ff.
128 On Pomponazzi see Walker, Spiritual and demonic magic (ref. 46), 107ff. On Fernel:
Henry and Forrester, Jean Fernel and the importance of his De abditis rerum causis (ref. 89). On Sennert: Newman, Atoms and alchemy (ref. 16). For general studies of this theme see Millen, Manifestation of occult qualities (ref. 15); and Henry, Magic and science (ref. 23).
129. For more details see Newman, Atoms and alchemy (ref. 16). See also Lynn S. Joy, Scientific explanation from formal causes to laws of nature in Park and Daston (eds), Cambridge history of science, iii (ref. 23), 70ff; and Andrew G. van Melsen, From atoms to atom: The history of the concept atom (New York, 1960).
130 Brian Vickers, Introduction in idem (ed.), Occult and scientific mentalities (ref. 14), 165.
121ff. Fludd's work has even been considered alongside that of Agrippa and Cardano: Silvia Parigi, La magia naturale nel Rinascimento: Testi di Agrippa, Cardano, Fludd (Turin, 1989).
132 Both Daniel Garber and Lynn S. Joy acknowledge the role of chemical ideas in early modern changes in natural philosophy. See Daniel Garber, Physics and foundations and Lynn S. Joy, Scientific explanation from formal causes to laws of nature in Park and Daston (eds), Cambridge history of science, iii (ref. 23), 298ff, and 70ff, respectively.
133. See Henry and Forrester, Jean Fernel and the importance of his De abditis rerum causis (ref. 89); Sylvain Matton, Hermes et les alchimistes (Corpus, xli (2002), 135ff; Nutton, The seeds of disease (ref. 124); and idem, The reception of Fracastoros theory of contagion (ref. 124). As representative of the Paracelsians, consider Severinus: Jole
Shackelford, A philosophical path for Paracelsian medicine: The ideas, intellectual context, and influence of Petrus Severinus (1540/2-1602) (Copenhagen, 2004).

134. Girolamo Fracastoro, De sympathia et antipathia rerum (Lyons, 1554). Girolamo Cardano, De subtilitate libri XXI (Basle, 1554). The book mentioned is Book XVIII, but is by no means the only book where Cardano draws upon occult ideas and attitudes.

48 135. Bernardino Telesio, De rerum natura iuxta propria pricipia libri IX (Naples, 1587). For Telesio, Campanella, and even Bacon’s credentials as magicians, see Walker, Spiritual and demonic magic (ref. 46), 189-193, 199-203, and 203-206. On Bacon’s semi-Paracelsian cosmology, see Graham Rees, Francis Bacon’s semi-Paracelsian cosmology, Ambix, xxii (1975), 81-101; and idem, Francis Bacon’s semi-Paracelsian cosmology and the Great Instauration, Ambix, xxii (1975), 161-173.

136. On Bruno, see (of course) Frances Yates, Giordano Bruno and the Hermetic tradition (London, 1964). See also Francesco Patrizi, Nova de universis philosophia libris quinquaginta comprehensa (Venice, 1593); and Magia philosophia Zoroaster et eius cccxx Oracula Chaldaica Hermetis Trismegisti Poemander (Hamburg, 1593).

137 Henry, Occult qualities (ref. 15).