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# Using Nothing:
# Vacuum, Matter, and Spirit
# in the
# Seventeenth Century Mechanical Philosophy

by

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Abstract

This thesis examines the implications associated with a notion of void in the seventeenth century mechanical philosophy of nature. The question of the existence of void became an important issue once basic, Aristotelian assumptions about the structure and operation of the world were challenged. The development of an alternative theory of matter challenged accepted theories within mechanics as well as raising theological, epistemological and metaphysical issues. The concept of void was linked, although not always overtly, to these deeper concerns. The void was difficult to reconcile to Christian theology because it raised questions about whether God could be active in spaces devoid of all matter. The ancient, pagan roots of atomism also troubled theologians. Epistemological concerns were also raised by those who questioned whether knowledge could be acquired about a non-corporeal entity and whether such an entity could have explanatory power as part of a system founded explicitly on the existence of only material entities.

This thesis examines three seventeenth century figures, Walter Charleton, Henry More, and Robert Boyle to illustrate the relationship between questions about interstitial void and concerns linked to fundamental conceptual assumptions. Each natural philosopher advocated a particular view of the

universe and the void as a direct result of his particular metaphysical assumptions. Their respective attitudes toward void resulted not merely from the supposed validity of their theories of nature but also according to how compatible each theory was to their theological presuppositions. Charleton transported Gassendi's Christianized version of Epicurean atomism to England in the mid-1600's. He attempted to maintain a distinction between metaphysics and physics while at the same time avoiding atheist complications. More, who was also committed to an atomist interpretation of natural phenomena, sought to modify Charleton's program by integrating theology within the materialism of the philosophy. He attempted this integration by making the void the receptacle through which a 'spirit of nature' was injected into the operations of the universe. Boyle avoided direct support for Epicurean atomism, perhaps because it was still tinged with atheism, and used the void as a heuristic device to explain certain natural phenomena such as rarefaction and condensation.

The various approaches taken by these supporters of atomism to the difficulties associated with the void shed light on several issues in the history and philosophy of science. Most significantly, they illustrate the importance of conceptual frameworks in the development of science.

## Acknowledgements

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Interacting with these people and experiencing the process of researching and writing this thesis has left me feeling very lucky. My only regret is that my mother died before I could share this excitement with her. My desire to attend university so that I could wonder about things, even if it is "nothing", was her gift to me. I wish she knew how much I love it.

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## Introduction

An examination of the development of science reveals that scientific thought did not arise in isolation but was influenced by other issues such as those associated with theology and metaphysics. Since these various branches of thought were not separated in the seventeenth century, issues important in them often overlapped. Where such an overlap created conflict, as between certain areas of theology and natural philosophy, reconciliation between conflicting perspectives was sometimes necessary. In the seventeenth century, natural philosophers questioned concepts about the basic material of the universe and how it operates to produce change. The resultant shift in thought led to explicit discussion of foundational concepts within theology, epistemology and metaphysics. In this thesis I shall examine the conflicts and attempts at reconciliation surrounding a notion of void in matter theory.

Various philosophies of nature challenged traditional Aristotelianism, which had dominated the world-view through the Middle Ages. By the seventeenth century, a mechanical and a Paracelsian or animistic interpretation of nature were vying for predominance. Each challenged basic Aristotelian assumptions about the nature of the world. Aristotelianism explained natural phenomena in terms of real qualities produced by the transformation of the four basic elements.

Accordingly, all material substance results from the combination of form and matter with neither component existing independently. Motion or change is either natural or forced and requires a cause. The velocity of motion is determined by the relationship between the heaviness of a body and the resistance of the medium.

This Aristotelian conceptual framework was challenged in the seventeenth century for many reasons. The Reformation raised philosophical concerns about the nature of knowledge and belief. Intellectual scepticism was also promoted by the humanist movement's recovery of ancient works, especially those by the sceptic, Sextus Empiricus. Their revival cast doubt on accepted methods which assumed knowledge could be certain. The Copernican revolution in astronomy challenged accepted notions of the structure of the universe and one's relationship to it as well as the epistemological status of scientific theories.[1]

These factors created an atmosphere within which several alternative explanations about how the world worked could be put forth. The Paracelsian outlook, an animistic philosophy of nature, viewed the world as a unified, organic network of magical and physical forces working in concert to produce natural phenomena. This outlook was strongly influenced by neo-Platonism, Pythagoreanism, alchemy and astrology and promoted the belief that people could unlock the secret mysteries of the universe through mystical

experience as well as observation.[2]

In contrast, the mechanical philosophy of nature did not view the universe as a living entity but explained all natural phenomena in terms of matter and motion alone.[3] The mechanists, however, did not present a unified front against the alternative philosophies of nature. Two versions of the mechanical philosophy arose. Both acknowledged the fundamental significance of matter and motion in explaining natural phenomena. However, they disagreed about the basic structure of matter and the possible existence of void. The atomist version was modeled after the ancient Epicurean philosophy and incorporated a notion of void.[4] The Cartesian version claimed no ancient heritage and denied the existence of void.[5]

The search, during the seventeenth century, for a philosophical framework to replace Aristotelianism, gave significance to concerns over the possible existence of void or empty space. As long as Aristotelianism was in place, basic assumptions about the nature of matter and motion made questions about the possible existence of void absurd. Two of Aristotle's arguments drew on the characteristics of motion to deny the existence of void. In Book IV of the Physics (214b 29-34) he argued against the void. Movement in a void would be random and without direction, because void is without a center, and since there is no observational evidence of this kind of movement, it follows

that void does not exist. Aristotle's second argument (215b 1-216a 8) is based on his theory that the speed of movement is inversely proportional to the resistance of the medium. Since void would provide no resistance, the velocity of motion in a void would be infinite, something he considered absurd. Therefore, Aristotle considered a notion of "the so-called void...to be really vacuous."[6]

Once these basic assumptions were challenged by the mechanists, the question of the existence of void became an important issue, linked to other problems arising in an attempt to formulate a new theory of matter. Since the atomists considered matter to be ultimately indivisible, void, or empty space between the discrete atoms, was a necessary correlative. Atomist theories of motion also required the existence of interstitial void.[7] The Cartesians, on the other hand, considered matter to be indefinitely divisible, leaving no empty spaces between matter particles.

Accepting or rejecting the possible existence of a vacuum in nature not only presented challenges for the development of mechanics but also raised theological, epistemological and metaphysical issues. The concept of void was linked, although not always overtly, to these deeper concerns. The question of the possible existence of the void raised questions about whether God could be active in spaces devoid of all matter. Epistemological concerns

were also raised by those who questioned whether knowledge could be acquired about a non-corporeal entity. An evaluation of the philosophical and theological implications of void reveals the interrelationship between physics and metaphysics in seventeenth century natural philosophy.

The idea of void had existed since antiquity. Leucippus is credited with the initial formulation of the concept in the 5th century B.C., in association with an atomist interpretation of nature. Democritus (c. 460-370 B.C.), Epicurus (341-270 B.C.), and Lucretius (99-55 B.C.) each endorsed the theory that the only realities in the universe are atoms and void. They formulated this philosophy of nature as a response to Eleatic and philosophical demands. The Presocratic philosopher, Parmenides (fl. 6th c. B.C.) established the Eleatic school and, in an attempt to develop a logically consistent cosmology, rejected any notion of change and movement by suggesting that plurality is illusion. This philosophy grew out of his criticism of the common pre-Socratic assumption that something can come from nothing. He reduced the reality of everything to an unchanging One. The atomist interpretation of nature attempted to respond to this tradition by proposing that all nature was composed of indestructible, homogeneous, unchanging atoms. Moreover, the materialism of atomism was an attempt to relieve human fears of death and the after-life by considering the gods

irrelevant to both the natural and human realms and by asserting that the soul, which is composed of atoms, simply dissipates at death.[8] Although not explicitly godless, this part of the atomist program, which viewed the gods as removed from and uninterested in human affairs, gave Epicureanism the reputation of atheism. Advocates of the mechanical philosophy consequently feared their support of atomism would be seen to imply support of atheism and therefore sought to rid atomism of its atheist implications.

Our knowledge of these ancient atomists comes from accounts of Lucretius who endorsed atomism and accepted the existence of void. Diogenes Laertius also gave an extensive account of atomism in Book X of his Lives of Eminent Philosophers which dealt with Epicurus and preserved several of his original writings. On the other hand, Aristotle was critical of atomism. The fundamentals of his cosmology denied the existence of void by stipulating that nature abhors a vacuum and actively seeks to prevent its occurrence. Further information about atomism came from Hero of Alexandria (fl. 1 c. A.D.) who proposed the existence of interstitial void. His support for such a notion seems to have originated not from the ethical or spiritual concerns of the first atomists, but from his attempt to explain the action of pumps and siphons.[9]

During the Middle Ages, the existence of interstitial vacua was almost unanimously rejected because of the

widespread acceptance of the Aristotelian world-view. While there were some anti-Aristotelians who believed in interparticulate vacuum, such as Nicholas of Autrecourt in the early 1300's, the Aristotelians were generally successful in defending their position against the existence of vacuum.[10] Any notion of void considered at that time was primarily associated with extracosmic rather than interstitial space.[11]

A broader discussion of the possible existence of interparticulate void did not occur until the seventeenth century, when mechanical philosophies of nature seriously challenged traditional Aristotelianism. Fundamental shifts in the very concept of matter itself made consideration of the void possible for seventeenth century natural philosophers. Rather than being understood in relation to Aristotelian forms or qualities, matter came to be seen as "self-subsistent actuality."[12] This new perception, which identified the purely physical as matter, required shifts in other concepts such as divisibility, continuity and infinity. Changes to perceptions of the fundamental structure of matter led invariably to changes in associated perceptions of how matter operated. For example, an assumption that matter was composed of discrete atoms, like tiny billiard balls, rather than being an extended continuum, implicitly required a notion of void in order to accomodate the discreteness and plurality of separate

bodies.[13]

Various experiments made the existence of interstitial void more plausible. The barometric experiments of Torricelli and Pascal in the early 1600's provided evidence that seemed to refute the Aristotelian claim that nature abhors a vacuum. The action of suction pumps was explained through reference to atmospheric pressure. The study of pneumatics was refined further by von Guericke and Boyle who designed pumps to create artifically what some considered to be a vacuum. The arguments over whether or not a vacuum did in fact exist within the evacuated pump centered around basic assumptions about the structure of matter. Atomists used these experiments as evidence for particulate theories of matter, with its correlative void.[14]

In considering the void, historians of science have focussed almost exclusively on analyses of extracosmic space, with very little study of the implications of interstitial space. David Furley outlines arguments used by Aristotle against the atomist theory of interstitial void. He highlights those arguments which focused on problems about motion.[15] Edward Grant's work provides the most detailed description of the development of the notion of extracosmic void from the ancients to the absolute space of Newton.[16] The growing importance of experimentalism in promoting acceptance of void is pointed out by Charles B. Schmitt, who also credits this activity with attempts to

understand motion.[17] Charles Webster argues that the vacuist/plenist controversy of the seventeenth century resulted from increased experimentalism and that experimental work with air promoted questioning of basic philosophical tenets.[18] Marie Boas also suggests that interest in pneumatics developed in the sixteenth century after translations of Hero of Alexander's first century works were recovered.[19] However, Ivor Leclerc provides convincing evidence to suggest that shifts in philosophical perceptions preceeded experimental investigation of the nature of matter. He outlines the development and shift of concepts about matter from ancient times to the seventeenth century, suggesting that conceptual shifts led to increased experimentalism.[20]

Some scholars completely disregard the importance of void in the development of seventeenth century matter theory. John Roche suggests that increased interest in understanding the kinematic and dynamical properties of matter was the main impetus for natural philosophy rather than any interest in the internal structure of matter.[21] While Christoph Meinel points out the importance of keeping any new philosophy of nature compatible with theological assumptions in the seventeenth century, he does not address the implications of void in achieving such compatability.[22]

Other scholars focus on social and ideological issues in order to explain and evaluate developments within

seventeenth century science. James R. Jacob, in particular, puts more emphasis on political and social factors to explain why certain approaches to natural philosophy were taken. Using this perspective, the rising fear of atheism is explained as a reaction to the increasing number of radical sects in the 1650's who challenged all established authorities, including the church. Less emphasis is put on metaphysical or epistemological issues by such social historians. The desire to prove the immortality of the human soul is also considered to be linked more to political rather than theological or metaphysical issues. While socio-ideological factors are significant in determining theological positions, there are several reasons why they will not be addressed in this thesis. Firstly, the theological and metaphysical issues to be considered had a long-standing history that can be considered apart from the ideological or political issues current in seventeenth century England. Furthermore, the particular implications and complications associated with the development of a notion of void in the mechanical philosophy of nature were more directly related to theological and metaphysical issues than to particular political or social issues.

This thesis focuses on three seventeenth century figures, Walter Charleton, Henry More and Robert Boyle in order to illustrate the relationship between questions about the interstitial void and concerns linked to fundamental

conceptual assumptions. Each natural philosopher advocated a particular view of the universe and the void as a direct result of his particular metaphysical assumptions. Their respective attitudes toward void resulted not merely from the supposed validity of their theories of nature but also according to how compatible each theory was to their theological presuppositions. Any concept that attempted to explain natural phenomena had to fit within their theological assumptions.[23]

Walter Charleton transported Gassendi's Christianized version of Epicurean atomism to England in the mid-1600's.[24] The resurrection of this ancient theory, with its reputation of atheism, required some modifications in order to make it compatible with seventeenth century theological assumptions. Closely following Gassendi, Charleton sought to accomplish this not only through revisions allowing for the presence of a divine creator but also by establishing the limits to the mechanization of the world. He attempted to establish the bounds of the mechanical philosophy by clearly demarcating those physical phenomena which could be explained using a mechanist approach from what could not be explained with such an approach, things such as angels, the human soul and God. To strengthen explanations from within the mechanical framework, Charleton provided analogies from theology. The general acceptance and importance of incorporeals within this context lent credence to his claim for the existence of

incorporeals in the physical world. His straightforward attempt to prove the reality of void relied more on ancient atomist arguments than on empirical evidence. His careful avoidance of equating the incorporeals from the two contexts, however, indicates his concern lest such an interpretation suggest the deification of nature.

Henry More transported the Cartesian version of mechanism to England but later converted to an atomic interpretation, partly because of his decision to accept the void.[25] He thought that this aspect of mechanism supported his belief in immaterialism, and thereby lent strength to the existence of an immortal soul. More, like Charleton, sought a version of the mechanical philosophy which was compatible with Christian theology. Like Charleton, More was aware of the possible association between atomism and atheism, and sought to reconcile the physics of the atomist version of the mechanical philosophy and Christian theology. He attempted to explain certain natural phenomena, such as cohesion and magnetism, which had not previously been successfully explained, using a mechanical framework. He also used the void as the means to integrate atomism and theology, a tactic which would clear up these explanatory problems as well.[26] The void became the receptacle through which a 'spirit of nature' could be injected into the operations of the universe thereby bridging the gap between the mechanical explanations and the presence of immaterial

entities such as God, angels and the immortal soul. Rather than acknowledging the existence of void as a necessary condition of matter, as Charleton had done, More argued for the existence of void as a necessary condition for spirit. In order to avoid accusations of pantheism, More was careful to proclaim his 'spirit of nature' as not being synonymous with God but merely his instrument. His attempt to prove the reality of void was clearly motivated by his theological concerns.

Unlike Charleton and More, Robert Boyle chose not to incorporate theological and metaphysical issues explicitly into his version of the mechanical philosophy. While one could easily interpret Boyle's extensive pneumatic experiments as an attempt to draw some definitive conclusions about the existence and significance of a vacuum in nature, such is not the case. He openly declared himself neither for nor against the existence of void and explicity avoided involvement in the controversy. By introducing the term "corpuscularianism" to describe all versions of the mechanical philosophy inclusively, Boyle hoped to sidestep the whole issue of the theological and metaphysical implications associated with the void and to use it simply to explain certain natural phenomena. He found it a useful heuristic device and only supported the hypothesis of its existence when arguing against More's spirit of nature theory. His reluctance to confirm its reality points to his

fear of its atheistic associations. Therefore, while not overtly associating theology with natural philosophy, Boyle's program was fundamentally moulded by such associations and assumptions.

All three figures sought to explain natural phenomena in terms of matter and motion alone. They each believed that the mechanical philosophy provided better explanations of natural phenomena by describing cause in terms of primary characteristics of matter. However, the success of mechanical, and particularly atomic, explanations of such phenomena as rarefaction and condensation was counter-balanced by certain difficulties. An acceptance of the existence of distinct, indivisible atomic particles implied, as a necessary correlative, the existence of void. In the mid-seventeenth century, such a notion was difficult to reconcile not only to the basic principles of the mechanical philosophy but also to Christian theology.

One of the most worrying problems associated with the void was the threat of atheism. Theologians were troubled by the ancient, pagan roots of atomism which did not acknowledge divine creation or intervention, providence, or an immortal soul. The materialist overtones associated with atomism, and therefore with void, troubled supporters of this version of the mechanical philosophy.

Secondly, there was concern about the possibility of confusing void with Aristotelian forms and essences.

Mechanists loudly criticized the occult, qualitative explanations of Aristotelianism. They did not want to present an alternative explanation that could be mistaken for just another formal quality with no quantifiable attributes, after proclaiming this very feature to be the foundation of their new philosophy of nature. Such confusion could lead to a return to explanations which relied on internal characteristics acting on matter to produce change rather than God's directive powers acting on inert matter.

A third difficulty centered around the problems of postulating the existence of an entity with no material characteristics as part of an explanatory system founded explicitly on the existence of only material entities. Difficulties with proving the existence of unobservable material entities, such as atoms themselves, were overcome by a transdictive 'leap.' Using such a method, it was considered acceptable to draw conclusions about unobservable entities based on observations of observables. Therefore, Boyle, for instance, believed unobservable atoms were real since observable results supported that belief.[27] Nonetheless, this inference, inductive though it was, remained within the sphere of the material world. Interparticulate void, however, was unobservable, not because it was small, like an atom, but because it was an entirely non-corporeal entity, altogether beyond the sphere

of material perception.

The various approaches taken by supporters of atomism in order to deal with these difficulties shed light on a variety of issues in the history and philosophy of science. They illustrate the issues involved, for instance, with the epistemological status of scientific theory during the seventeenth century. Natural philosophers struggled to establish the boundaries of what could or could not be accepted as an explanatory device. I shall examine these issues by focusing on how Charleton, More and Boyle developed their versions of the mechanical philosophy of nature and how they incorporated or denied the void to accomodate the philosophical and theological implications linked to these particulate theories of matter.

## Notes - Introduction

1. The impact of the Reformation on 17th century thought is discussed in R.S. Westfall, Science and Religion in Seventeenth Century England (Ann Arbor: Yale University Press, 1958). For the growth of scepticism and its impact on the development of a new world-view see R.H. Popkin, The History of Scepticism from Erasmus to Spinoza (Berkeley: University of California Press, 1979); B.J. Shapiro, Probability and Certainty in Seventeenth Century England (Princeton: Princeton University Press, 1983); H.G. Van Leeuwen, The Problem of Certainty in English Thought. 1630-1690 (The Hague: Martinus Nijhoff, 1963). The impact of the Copernican revolution is discussed in T.S. Kuhn, The Copernican Revolution. Planetary Astronomy in the Development of Western Thought (Cambridge: Harvard University Press, 1957). Intellectual shifts that took place in the transition from Aristotelianism to mechanism are pointed out in Gary B. Deason, "Reformation Theology and the Mechanistic Conception of Nature," in God and Nature. Historical Essays on the Encounter between Christianity and Science, ed. D.C. Lindberg and R.L. Numbers, (Berkeley: University of California Press, 1986).

2. An overview of the animist world-view is presented in R.S. Westfall, The Construction of Modern Science (Cambridge: Cambridge University Press, 1971; pp. 25-33); W. Pagel. Paracelsus. An Introduction to Philosophical Medicine in the Era of the Renaissance (Basel: Karger, 1982); B. Vickers, ed., Occult and Scientific Mentalities in the Renaissance (Cambridge: Cambridge University Press, 1984); A.G. Debus, The Chemical Philosophy. Paracelsian Science and Medicine in the Sixteenth and Seventeenth Centuries, 2 vol., (New York: Neale Watson Academic Pub., 1977); A.G. Debus and R. P. Multhauf, Alchemy and Chemistry in the Seventeenth Century (Los Angelas: Wm. Andrews Clark Memorial Library, 1966). The influence of Hermeticism is presented in F.A. Yates, "The Hermetic Tradition in Renaissance Science," in Art, Science and History in the Renaissance (Baltimore: Johns Hopkins Press, 1967); F.A. Yates, Giodano Bruno and the Hermetic Tradition (London: Routledge & Kegan Paul, 1964).

3. See R.S. Westfall, The Construction of Modern Science, pp. 30-64 for an overview of the mechanical philosophy as well as M. Boas, "The Establishment of the Mechanical Philosophy," Osiris 10 (1952): 412-541; E.J. Dijksterhuis, The Mechanization of the World Picture. Pythagoras to Newton (Oxford: Clarendon Press, 1961).

4. For a description of the transmission of atomism to England and its development there see R. Kargon, Atomism in England from Hariot to Newton (Oxford: Clarendon Press, 1966). For more general histories of atomism see A. Rupert Hall, The Revolution in Science. 1500-1750 (London: Longman, 1954); J.R. Partington, "The Origins of the Atomic Theory," Annals of Science 4 (1939): 245-282.

5. For an outline of the basic differences between the atomist and Cartesian versions of the mechanical philosophy see Herbert Butterfield, The Origins of Modern Science. 1300-1800 (Thetford, Norfolk: Lowe & Brydone, 1957; repr., Toronto: Clarke, Irwin & Co. Ltd., 1977), Ch. VII.

6. Aristotle, Physics ed. Jonathan Barnes (Princeton: Princeton University Press, 1984), Book IV, 216b 27-28. A full presentation of the Aristotelian theory of motion and matter can be found in E.J. Dijksterhuis, The Mechanization of the World Picture; F. Copleston, A History of Philosophy, Vol. 1, (New York: Doubleday, 1962); I. Leclerc, The Nature of Physical Existence (London: Geo. Allen & Unwin Ltd., 1972); Alexander Koyré, "Galileo and Plato," Journal of the History of Ideas 4 (1943): 400-428; David Furley, The Greek Cosmologists. The Formation of the Atomic Theory and its Earliest Critics, Vol. 1, (Cambridge: Cambridge University Press, 1987), Ch. 13.

7. This argument is a reiteration of the one used by Diogenes Laertius in Book X of his Lives and Opinions of Eminent Philosophers in Ten Books, 40-41. (R.D. Hicks, Trans. Loeb reprint. Cambridge: Harvard University Press, 1925;revised 1938, 1942, 1950). It is also presented by Lucretius in De Rerum Natura Book I, 329-370. (W.H.D. Rouse, Trans. Loeb reprint. Cambridge: Harvard University Press, 1922).

8. Lucretius, De Rerum Natura (W.H.D. Rouse and M.F. Smith, Trans., Loeb reprint, 2nd Ed. Cambridge: Harvard University Press, 1982;first pub. 1924), Book I, 102-136; 146-159; 483-503. For information about Parmenides and other Pre-Socratic philosophers see G.S. Kirk and J.E. Raven, The Pre-Socratic Philosophers (Cambridge: Cambridge University Press, 1957), Ch. 1-6. These philosophers, as well as the atomists, are also dealt with in David Furley, The Formation of the Atomic Theory and its Earliest Critics Vol. 1. (Cambridge: Cambridge University Press, 1987).

9. See B. Woodcroft (Ed., Trans.), The Pneumatics of Hero of Alexandria (London: Taylor, Walton & Maberly, 1851) for a translation of Hero's treatise in support of interstitial vacuum.

10. Various works focus on the concept of void during the Middle Ages. C.B. Schmitt, "Changing Conceptions of Vacuum: 1500-1650," Proc. XI Int. Congress of the Hist of Science (Warsaw and Krakow: 1965), pp. 340-343 traces the development of ideas concerned with a vacuum as they shifted in the Renaissance and 17th century. Edward Grant's Much Ado About Nothing. Theories of Space and Vacuum from the Middle Ages to the Scientific Revolution (Cambridge: Cambridge University Press, 1981) describes the Aristotelian and medieval explanations for rarefaction and condensation as well as their arguments against atomist explanations. Further discussion of these issues is found in E. Grant's, "Medieval Explanations and Interpretations of the Dictum that 'Nature Abhors a Vacuum'," Traditio 29 (1973): 327-355. For a discussion of how the Aristotelian concept of place prevented consideration of both interstitial and extramundane space see Edward Grant, "Place and Space in Medieval Physical Thought," in Motion and Time. Space and Matter. Interrelations in the History of Philosophy and Science, ed. P.K. Mackamer and R.G. Turnball, (Columbus: Ohio State University Press, 1976), 137-167. Discussion of Nicholas of Autrecourt's contribution to a notion of void can be found in E. Grant's "The Arguments of Nicholas of Autrecourt for the Existence of Interparticulate Vacua," Proceedings of the XIIe International Congress for the History of Science. The Latin text of Nicholas of Autrecourt's treatise on the void can be found in J. Reginald O'Donnell, "Nicholas of Autrecourt," Medieval Studies 1 (1939): 179-280.

11. One consequence of the papal bans of 1277 was the examination of whether extracosmic space could in fact exist. See Edward Grant's "Science and Theology in the Middle Ages," in God and Nature, pp. 49-75 for a discussion of the impact of the 1277 ban on the development of scientific inquiry into the existence of extracosmic void.

12. Ivor Leclerc, The Nature of Physical Existence (London: Geo. Allen & Unwin Ltd., 1972), 35.

13. Ibid, 177-178.

14. An outline of the various experiments devised to both prove and disprove existence of void is found in Charles B. Schmitt, "Experimental Evidence for and against a Void: The Sixteenth-Century Arguments," Isis 58 (1967): 551-571. A history of early vacuum experiments is provided in E.N. da C. Andrade, "The Early History of the Vacuum Pump," Endeavor 16 (1957): 29-41. For a detailed outline of Boyle's vacuum experiments see James Bryant Conant, ed., "Robert Boyle's Experiments in Pneumatics," in Vol. 1, Harvard Case Histories in Experimental Science (Oxford: Oxford University Press, 1948), 1-64. Charles B. Schmitt in, "Changing Conceptions of Vacuum: 1500-1650," Proceedings of the XI International Congress of the History of Science. (Warsaw and Krakow: 1965) that Aristotelianism was more easily refuted

because of technological advances that allowed the artificial creation of vacuum in experiments. For discussion of the political and epistemological use of vacuum experiments see Steven Shapin and Simon Schaffer, Leviathan and the Air-Pump. Hobbes, Boyle, and the Experimental Life (Princeton: Princeton University Press, 1985).

15. David J. Furley, "Aristotle and the Atomists on Motion in a Void," in Motion and Time. Space and Matter. Interrelations in the History of Philosophy and Science (Columbus: Ohio State U. Press, 1976), 83-100. Exposure to Aristotle's motion arguments against void was also provided by Professor J.J. MacIntosh. Other discussions of problems associated with the questions of motion in a void can be found in James A. Weisheipl, "Motion in a Void: Aquinas and Averroes," in Thomas Aquinas 1274-1974. Commemorative Studies (Toronto: Pontifical Institute, 1974).

16. see Edward Grant, Much Ado About Nothing. Theories of Space and Vacuum from the Middle Ages to the Scientific Revolution (Cambridge: Cambridge University Press, 1981). For further discussion of extracosmic space see E. Grant, "Medieval and Seventeenth-century Conceptions of an Infinite Void Space beyond the Cosmos," Isis 60 (1969): 39-60 and E. Grant, "The Principle of the Impenetrability of Bodies in the History of Concepts of Separate Space from the Middle Ages to the Seventeenth Century," Isis, 69 (1978): 551-571.

17. Charles B. Schmitt, "Changing Conceptions of Vacuum. 1500-1650." Proceedings of the XI International Congress of the History of Science (Warsaw, Krakow, 1965), 340-343.

18. Charles Webster, "The Discovery of Boyle's Law, and the Concept of the Elasticity of Air in the Seventeenth Century," Archives for the History of Exact Sciences 2 (1965): 441-502.

19. Marie Boas, "Hero's Pneumatica. A Study of its Transmission and Influence," Isis 40 (1949): 38-48.

20. Ivor Leclerc, The Nature of Physical Existence (London: Geo. Allen & Unwin Ltd., 1972).

21. John Roche, "Theories of Matter in the Seventeenth Century," in The Physical Sciences Since Antiquity, ed. Rom Harré, (London: Croom Helm, 1986), 41-62.

22. Christoph Meinel, "Early Seventeenth-Century Atomism. Theory, Epistemology, and the Insufficiency of Experiment," Isis 79 (1988): 68-103.

23. Margaret J. Osler, "Baptizing Epicurean Atomism: Pierre Gassendi on the Immortality of the Soul," in Religion, Science, and Worldview ed. Margaret J. Osler and Paul L. Farber (Cambridge: Cambridge University Press, 1985), 164.

24. For the importance of Gassendi in the development of atomism see Margaret J. Osler, "Baptizing Epicurean Atomism: Pierre Gassendi on the Immortality of the Soul," in Religion, Science, and Worldview, 163-184; and Margaret J. Osler, "Fate, Fortune, and Divination: Gassendi's Voluntarist Theology and the Baptism of Epicureanism," in Atoms, Pneuma, and Tranquility: Epicurean and Stoic Theories in European Thought, ed. Margaret J. Osler, (Cambridge: Cambridge University Press, forthcoming).

25. See Flora I. MacKinnon ed. and trans., Philosophical Writings of Henry More (New York: AMS Press, 1925), 249 for a discussion of the transmission of Cartesianism to England. While other scholars have credited the transmission of this information to little-known contemporaries of More's, MacKinnon provides evidence to show that More was discussing Descartes' ideas earlier than other publications. The opinion that More was one of the first to bring the Cartesian philosophy of nature to England is also supported by Leonora D. Cohen, "Descartes and Henry More on the Beast-Machine - A Translation of their Correspondence Pertaining to Animal Automatism," Annals of Science 1(1936): 48-61. Alan Gabbey, "Philosophia Cartesiana Triumphata: Henry More (1646-1671)," in Problems of Cartesianism, ed. T.M. Lennon, J.M. Nicholas and J.M. Davis (Kingston and Montreal: McGill-Queen's University Press, 1982) also suggests that More introduced the term Cartesianism into English (171).

26. See John Henry, "Occult Qualities and the Experimental Philosophy: Active Principles in Pre-Newtonian Matter Theory," History of Science 24 (1986): 335-381. This article discusses the problems faced by natural philosophers trying to maintain Christian assumptions while promoting mechanism. Henry More was not the only one trying to reconcile these two areas, for "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." (357).

27. For a thorough discussion of transdiction see Maurice Mandelbaum, Philosophy Science and Sense Perception: Historical and Critical Studies (Baltimore: Johns Hopkins Press, 1964), Ch. 2.

# Chapter One

## Walter Charleton

## Void and the Limits of Mechanism

Walter Charleton (1619-1707) has gained historical importance for his advocacy of an atomist version of the mechanical philosophy in England, during the 1650's. Although he himself was not noteworthy for the development of original scientific concepts, in the manner of Robert Boyle or Isaac Newton, Charleton was nonetheless important for his dissemination of Pierre Gassendi's version of Epicurean atomism which sought to explain all natural phenomena in terms of matter and motion alone. Atomism founded such explanations on the acceptance of indivisible atoms separated by void. Following Gassendi, Charleton argued for the existence of both these entities and broke with Aristotelian explanations of matter by proposing vacuum to be a necessary condition for its existence. Without the existence of vacuum he thought that it is impossible to explain certain material processes such as rarefaction and condensation adequately. Charleton claimed that these material occurrences can only be understood in terms of a non-material entity. In this fashion, Charleton established the parameters within which the mechanical philosophy of nature could serve to explain all phenomena within the physical world.

According to Charleton, however, mechanical explanations could not explain incorporeal phenomena beyond the realm of the physical world, things such as God, angels and the human soul. These metaphysical concerns, while occupying a significant component of Charleton's program, did not overlap with that part of his program which addressed physical phenomena. While void was, according to Charleton, an actually-existing entity which explained rarefaction, it was an entirely different kind of incorporeal from the soul. Nonetheless, this difference did not prevent Charleton from referring to the existence of an incorporeal soul in the human body in order to render the notion of void in non-active material bodies plausible. While not explicitly equating soul with void, Charleton appealed to one in order to support the other. Theological assumptions lent credence to his atomist philosophy of nature but were not completely integrated within it. Theology, based on faith, complemented mechanism, grounded in reason, while at the same time remaining distinct from it.

Charleton not only brought atomist ideas to England from the Continent, but also popularized them, making them more available to the people involved directly in experimentation and evaluation of philosophical approaches to nature. Charleton became the English advocate of Epicurean atomism.[1]

Educated as a physician, he spent his early years at Oxford, with John Wilkins as one of his teachers. Although not excelling at creative thought, Charleton was very accomplished in the synthesis and evaluation of the work and thought of others.[2] In such a way he became familiar with prominent natural philosophers such as John Evelyn, William Harvey and Kenelm Digby.

Charleton was appointed Royal Physician in 1643 and served as president of the Royal Society of Physicians (1689-1691). He wrote many books on a variety of subjects, ranging from topics in medicine to the origins of Stonehenge.

Initially attracted to the ideas of van Helmont, Charleton translated some of his work, but later became an advocate of atomism, having been influenced by Gassendi, Descartes and Hobbes.[3] He openly declared his indebtedness to Gassendi in The Darkness of Atheism (1652) when he acknowledged that, "many of our Apodictical Reasons...were gleaned from...chiefly Gassendus..."[4] In his Physiologia. Epicuro-Gassendo-Charletoniana (1654), which was actually a paraphrased translation of one of Gassendi's works, Charleton confirmed that it had been formulated, "for the most part, according to the lines drawn on those excellent Charts of Epicurus and Gassendus."[5] Charleton was well-known and respected by his contemporaries.[6] He was in contact with prominent philosophers on the Continent such as

Descartes, Gassendi and Mersenne. It has also been suggested that Charleton spent time in Paris where he had opportunity to talk with Thomas Hobbes.[7] Through these connections, Charleton was exposed to ideas supporting a mechanistic explanation of natural phenomena. It was Gassendi's presentation of Epicurean atomism that Charleton chose to defend since he considered it to be more easily reconcilable to Christian assumptions than other philosophies of nature such as Paracelsianism.

Charleton defended atomism because he thought it provided explanations closer to the truth than alternative philosophies of nature. Therefore, he noted that he had

> deserted the Doctrine of the Aristotelians...and addicted ourselves to the Sect of the Epicureans, on any other Interest, but that sacred one of Verity.[8]

Through pronouncements of rationality and common sense he sought to prove the truthfulness of his preferred theory. He believed that

> the Atoms of Epicurus have more of probability, and hold rational through most of those operations, which ocurr to the curiosity of the Philosopher, with more familiarity to our conceptions.[9]

Throughout the Physiologia, in which Charleton presents an atomist interpretation of natural phenomena, or of, "the whole of that vast and deep Ocean of Sublunary Corporeal Natures,"[10] he described traditional, Aristotelian, as well as alternative explanations of various phenomena such as

colour, light, taste and sound. Invariably, however, he considered a mechanical explanation founded on the assumption of atoms and void to be the best. Because of

> these Instances, and the insufficiency of any other Dihoties, to the rational explanation of them, with due attention and impartiality perpended; we cannot but highly applaud the perspicacity of Epicurus, who constantly held, that the Motion of Mutation was a species of Local Transition[11]

In putting forth an atomist interpretation of nature and its phenomena, Charleton acknowledged the existence of both atoms and void, body and inanity, material and non-material entities. However, before establishing the credibility of his atomic interpretation of body, Charleton presented the alternative theories. The Aristotelian theory, which was most firmly established at that time, stated that tangibility determines body. The Epicureans would have agreed with this definition, holding that

> by Bodie is to be understood a congeries of figure, magnitude, resistence (or solidity and impenetrability mutual) and gravity.[12]

Charleton contrasted the atomists to Descartes who asserted that extension was the "Essential Property of a Body"[13] and that

> the Essence of matter, or a Body considered in the General doth not consist in its hardness, weight, colour, or any other relation to the senses; but only in its Extension into the three Dimensions.[14]

Next, Charleton identified the atomists who, "by an excessive acuteness of Wit" derive a theory of body from

extension and substance. Without a theory relying on these two components, Charleton reasoned, an explanation of condensation and rarefaction would be impossible. The substance, or quantity, of a particular body is not defined merely by the area which it encompasses or its extension but is determined by the ratio between material atoms and non-material void. Therefore, the area encompassed by a substance results from the number of material, tangible atoms and the amount of non-material void present in the substance.

Using this theory, Charleton argued that body can be understood only in terms of non-body or vacuum. An implicit part of body is that very entity which is itself without body. If a substance has many "Intervals or Interstices, repleted with no Bodies"[15] it will be rarefied. On the other hand, if these spaces are fewer, the body will be condensed. Therefore, since rarity and density are directly proportional to the amount of void space in a body, one can

> desume the more or less of Rarity in any body, from the more or less of Vacuity intercepted among the parts thereof; and on the contrary, the more or less Density from the greater or less exclusion of Inanity, by the reduction of the parts of a body to mutual Contingency.[16]

It is therefore an error to equate the substance of a body with its extension, as the Cartesian mechanists did. Rather one should

> define a Rare Body to be such, as obtaining little of Matter, posseseth much of Place; and on the contrary, a Dense one to be that, which obtaining

much of Matter, possesseth little of Place.[17]

Charleton considered any alternative to such an explanation of rarefaction and condensation as inevitably leading to great difficulties such as having to accept that, "all bodies in the Universe must be equally Dense, or equally Rare."[18] This was, for Charleton

> the least of which unconcealable Absurdities (not to enumerate any others of those many that depend on the same Concession of an absolute Plenitude, or no Vacuity) is great enough to render those Heads, which have laboured to destroy the Vacuola of Epicurus, strongly suspected of Incogitancy, if not of stupidity.[19]

Charleton believed matter and void to be the only two entities actually existing, comprising the fundamental units of the universe. Atoms congregate into

> these Molecules, First Masses, or smallest Concretions of Atoms, [and] are the Proxime and Immediate Principles of Fire, Water, Aer, and of other things more simple, such as the Chemists conceive their Three Catholique Principles, Salt, Sulphur, and Mercury to be: from which afterward congregated and commit'd into greater masses, arise various kinds of Bodies, respectively to the various manners of their commistion, disposition, and concretion:as Animal, Vegetable, Minerals.[20]

For Charleton, "Atoms are the First and Catholique Principle of Bodies" and "are not Mathematical Insectiles, but Material Realities."[21] They are finite in number and size, and occur in a variety of shapes. They are corporeal, solid, heavy and indivisible but so small that they are insensible to the human senses. Charleton put forth several arguments to prove that atoms are indeed the material from

which all matter is composed. He founded the first argument on the assumption that "Nature can produce Nothing out of Nothing; nor reduce any thing to Nothing."[22] It is therefore apparent that a fundamental, basic unit must exist from which all other things are produced. Atoms are these basic building blocks, according to Charleton.

His second argument centered around the claim that finite things have to be created out of other finite things. Because nature "cannot in her Dissolution of Bodies, proceed to Infinity" there simply must be some ultimate unit from which other things are composed. For nature is a "translator" not a creator. Furthermore, because nature is constant it makes sense to suppose that atoms exist because they are "Certain, Constant, and inobnoxious to Dissolution."[23]

The physical correlative to atoms is void. Charleton set the stage for his discussion of interstitial vacuum by first presenting various accounts of its nature. Epicurus described it as "a Region, or Space, and a Nature that cannot be touched."[24] According to this definition, vacuum is the exact opposite of body. Cleomedes, on the other hand, described vacuum as

> incorporeal, because it cannot be touched, hath no figure of its own, nor is capable of any from others, neither suffers nor acts any thing, but only affords free space for the motion of other bodies through it.[25]

The theory of Empiricus, which held that vacuum was "Nature

devoid of all body," characterized void as a place or region when occupied by a material body.[26] In contrast, the traditional Aristotelian view held that vacuum was "a Place wherein no body is contained."[27] Since it is contradictary for a place to exist without a body, Aristotle concluded that vacuum was therefore impossible.[28]

Charleton agreed with those descriptions of void which considered it an incorporeal entity, impossible to be touched, but real nonetheless. His version of atomism assumed the reality of both atoms and void. Rather than being heuristic devices useful in explaining natural phenomena, these entities actually exist. Proof for the existence of atoms is difficult because they are beyond the capabilities of unaided human sensory experience. Proof for the existence of naturally-occurring void is even more difficult because it is impossible to sense.

> there remain many empty spaces (analogous to those Intervalls betwixt the incontingent Grains of Corn) so minute or exiguous, as to be below the perception and commensuration of sense. Which is the very Difficulty, concerning which there are so many Controversies extant, as their very Lecture would be a Curse to the greatest Patience.[29]

Undaunted by these difficulties, Charleton sought to prove the existence of both atoms and the void. His proof for the existence of atoms was based on assumptions about the structure and operation of nature. His proof for the existence of void similarly rested on speculations and assumptions. He argued that although it cannot be sensed,

the existence of vacuum can be inferred in a variety of ways.

> hence comes it that the thing Evident doth not Refragari to the Inevident. And thus the Suffragation [testimony] and Nonrefragation [nonopposition] of the Evidence of sense, ought to be understood as one Criterion, whereby any Position may be evicted to be true.[30]

Sense is only one criterion to determine existence, for

> there are many things, which are above the sphere of the Senses, [and which] may yet be as much within the reach of our Reason, as the most sensible whatever."[31]

Using this method of reasoning from the observable to the unobservable, Charleton could then draw conclusions about the existence of non-observables based on the nature or activity of observables. Since explanations of sensory experiences of the world were, according to Charleton's program, founded completely on entities difficult or impossible to sense, it was necessary to find a way of reasoning from observables to unobservables. Sense experience is obviously not directly operative in the arena of unobservables, but Charleton assumed that causal processes operative in the arena of sense experience were identical to those between unobservables and therefore believed he was justified in making a 'non-demonstrative inference'.[32] This inference, referred to by Mandelbaum as 'transdiction', allowed Charleton to conclude that vacuum must exist because it is a necessary requirement of motion, which, "is manifest from sense."[33] This argument reiterated

the classic syllogism of Sextus Empiricus which reasoned that, "If there be Motion, there must be Inanity; but Motion there is, therefore there is a Vacuum."[34] This argument supported Charleton's claim that

> our Apprehension or Judgment of any Object occurring to our sense, is exactly concordant to the reality thereof; or, that the Object is truly such, as we, upon the perception of it by our sense, did judge or opinion it to be.[35]

As a realist, Charleton acknowledged that sense perception is a reliable source of knowledge about the world, and he relied on transdiction to bridge the gap between observables and unobservables, even though it meant he was making inferences about entites which could not be directly experienced.[36] This reliance upon unobservables, however, did not lessen the strength of his argument because it was founded upon an unwavering belief in his realism. Therefore, since motion obviously occurs, it followed that interstitial vacuum must exist. For if the universe was a plenum

> there can be no beginning of Motion, and consequently no one Atome in the Universe can be moved...and therefore it remains, that every part of the Universe would be so firmly bound up and compacted by other parts, that to move those Cochles, Snails, or Insects, which are found in the ferruminated womb of Rocks, and incorporated to the heart of Flints, would be a far more modest attempt, then to move the least atome therein.[37]

Charleton continued to use transdiction in his arguments for the existence of interstitial void. Not only is the void necessary in order for motion to occur but also

to explain condensation and rarefaction. Charleton illustrated this through reference to various experiments with such apparatus as a pneumatique (wind gun) and aeolipile (hermetical bellows). He also fully described the barometric experiments of Torricelli. The advent of these experiments made examination of the void more accessible because the tiny, imperceptible interstitial spaces that naturally occur between atoms were artificially coalesced into bigger areas of "Praeternatural or Coacervate Inanity" through the actions of the various experiments.[38] The many "minute inane spaces [are] congregated into one sensible void space." While Charleton acknowledged that such experiments did not demonstrate irrefutably the existence of vacuum, he contended that they do offer

> occasion of many rare and sublime speculations, whereof some cannot be solved either so fully, or perspicuously by any Hypothesis, as that of a Vacuum Disseminatum among the insensible particles of Aer and Water[39]

Charleton assumed the reality of interstitial void based on these experimental observations. He extrapolated from observables in order to draw conclusions about unobservables, reasoning that even though

> those Her Instruments be invisible and imperceptible; yet are we not therefore to conclude, that there are none such at all.[40]

He assumed that the air in the wind gun could not be compressed unless void spaces exist between the air particles, just as grains of sand or wool fleece are

compacted when air spaces between them are made smaller. Another analogy supporting the same interpretation is that of

> an heap of dust dispersed by the Wind, [which] is rarefied into a kind of cloud and possesseth a far larger space then before its dispersion; because the disgregated Granules of Dust intercept wider spaces of the ambient aer[41]

Charleton continued his defense of interstitial void by contending that void is also necessary in order to receive the exhausts from combustion and other vapours. The air

> was created to be the Receptary of Exhalations: and that for the satisfaction of this End, it doth of necessity contain a Vacuum Desseminatum in those minute and insensible Incontiguities or Intervals betwixt its atomical Particles; since Nature never knew such gross improvidence, as to ordain an End, without the codestination of the Means requisite to that End...we intend; that the grand and most General Action of the Aer, is the Reception or entertainment of Vapours and Exhalations emitted from bodies situate in or near the Terraqueous Globe. And in this acception, allowing the Aer to be constituted the General Host to admit; we insinuate that it hath rooms wherein to lodge the arriving Exhalations[42]

Interstitial void is also needed to explain differences in density. The variation in density is attributed to "the greater or less Inane Spaces interspersed among their insensible Particles."[43] Another phenomenon Charleton used to support the notion of interstitial void is the manner in which salts dissolve in water. Since

> the Salt being in dissolution reduced...into its most minute or Atomical Particles, there ought to be in the Water Consimilar or adaequate Spaces for their Reception; and that those Spaces being once replenished, the Dissolution (because the Reception) ceaseth.[44]

Reviewing his claims, Charleton was emphatic.

> If this Vacuum Disseminatum of the Aer be submoved, and an absolute Plenitude in the Universe from a Continuity of all its parts supposed; then must every the smallest motion, with dangerous violence run through the whole Engine of the World, by reason of the Continuity...If the Aer were not endowed with such Porosities, other Bodies could never suffer the dilatation or rarefaction of themselves; since, upon the subtiliation or dilatation of their minute particles, i.e. the remove of their Atoms from a close to an open contexture, they possess 1000 times larger Capacities: and so there would be no room to entertain the continual Effluviums, expiring from all bodies passing their natural vicissitudes and degenerations.[45]

Therefore, Charleton explained a wide variety of natural phenomena on the assumption that unobservables provided the best explanation. He considered unobservable atoms and incorporeal void to be actually-existing since observable results fit the belief that they were. These explanations were all formulated from within a purely mechanical framework.

However, Charleton was aware that mechanical explanations had limits and, in particular, had no account for magnetism or cohesion.[46] The concept of void, as well, was difficult to grasp. After Charleton had exhausted all explanations which relied on a mechanistic interpretation he sought justification from his theological framework. Therefore, when difficulties within the mechanical philosophy arose, one should

> wind up the nerves of our Mind to a higher key of Conception, and let our Reason learn of our Faith

> to admit the possibility of a Body existent without Extension, and the Extension of a Body consistent without the Body it self; as in the sacred mystery of our Saviours Apparition to his Apostles, after his Resurrection...Not that we can comprehend the manner of either, i.e. the Existence of a Body without Extension, and of Extension without a Body, for our narrow intellectuals, which cannot take the altitude of the smallest effect in Nature, must be confest an incompetent measure of supernaturals: but that, whoever allowes the power of God to have formed a Body out of no praexistent matter; cannot deny the same power to extend to the reduction of the same Body to nothing of Matter again.[47]

When Charleton's efforts at transdiction from observable to unobservable within the mechanical framework did not provide convincing arguments for the existence of void, he resorted to a theological safety net to strengthen claims made from within the mechanical framework. In this manner, acknowledgement and acceptance of the existence of 'our Saviours Apparition', an incorporeal within the spiritual realm, lent credence to the existence of an interstitial void within the material realm while not considering them synonymous.

Charleton did not want to subsume his philosophy of nature completely within theological assumptions. However, since "the sounding Line of Mans Reason is much too short to profound the Depths, or Channels of that Immense Ocean, Nature," it was inevitable that reliance upon theological assumptions would be necessary from time to time in order to explain those entities or phenomena beyond the parameters of the mechanical framework.[48]

Although not always requiring confirmation from the theological framework, the mechanical philosophy of nature did have to be compatible with it at all times. Even though in many instances it did provide adequate explanations of natural phenomena, some adjustments to Epicurean atomism had to be made in order to achieve this compatibility.[49] Charleton, like Gassendi, was seeking to remove its atheistic implications. As a high Anglican he sought to maintain basic Christian assumptions and thought that atomism would be superior to other theories if some modifications were made to it.

> And truly, thus refined, the Hypothesis of Atoms is less guilty of either inconvenience or incertitude, than any other concerning the first material principle; nay, it hath thus much more of congruity and satisfaction then all the rest.[50]

Aware of the theological difficulties in Epicurean atomism Charleton proposed various changes to the theory. One of the main difficulties surrounded the origin of atoms which the Epicureans suggested had existed eternally. Charleton, however, modified this version to suggest that

> God, out of the Tohu, or infinite space of Nothing, called up a sufficient stock of the First Matter, for the fabrication of the World.[51]

Furthermore, Charleton criticized the Epicureans for assigning motion as an inherent characteristic of atoms. Calling such a notion a "Lunacy" Charleton proposed instead that God gave atoms motion at their creation. Charleton also objected to the Epicurean theory of infinity which

rejected a centre, something he considered necessary in order to explain gravity. After these modifications, Charleton believed that

> by virtue of these Correctives, the poisonous part of Epicurus opinion, may be converted into one of the most potent Antidotes against our Ignorance[52]

Compatibility with theology, however, did not imply integration. Always careful to ensure that his mechanism did not contravene any fundamental Christian assumptions, Charleton, at the same time, sought to maintain the distinction between those areas amenable to mechanical explanations and those requiring a theological perspective. While his piety did not allow him to promote a purely materialist program, he did not want a philosophy of nature totally reliant upon spiritual explanations.
Charleton's aim to maintain distance between mechanist and theological explanations is clear in the way he distinguished between types of non-material entities. After ensuring the compatibility of atomism with Christianity Charleton was aware of persistent problems associated with a notion of empty space or vacuum. A notion of extramundane space could possibly threaten Christian assumptions about the creation by suggesting the existence of an infinite void as a pre-existing, independent 'container' within which God could put the world.[53] Charleton acknowledged that

> here we discover our selves in danger of a nice scruple, deductive from this our Description of Space, viz. that, according to the tenor of our Conceptions, Space must be unproduced by, and

> independent upon the original of all Things, God.[54]

Charleton avoided accusations of impiety by declaring that extramundane space is,

> on the outside thereof, and denominate Imaginary: not that they are meerly Phantastical, as Chimaera's; but that our Imagination can and doth apprehend them to have Dimensions, which hold an analogy to the Dimensions of Corporeal substances, that fall under the perception and commensuration of the sense.[55]

By classifying extracosmic space as imaginary, and therefore as unreal, he avoided its theological complications. This particular maneuver had been used since antiquity to avoid equating void space with a divinity or postulating its existence as independent of God.[56]

As already noted, Charleton sought to prove the reality of other types of vacuum. While he avoided the theological problems associated with extramundane space by considering it to be imaginary, he avoided the atheistic association of interstitial space by ensuring its distinctiveness from the realm of spirit. Since he was careful not to equate interparticulate void with other non-corporeal entities such as angels, he avoided theological complications such as questions about the relationship between these miniscule spaces and God. Charleton circumvented these issues by declaring the differences between

> the Incorporiety of these Dimensions Spatial, from that adscribed to the Divine Nature, Intelligences Angelical, the Mind of Man, and other (if there be any) Incorporeal substances[57]

There are then, according to Charleton, two types of incorporeality within the universe. One is

> not only a simple Negation of Corporiety, and so of corporeal Dimensions; but also a true and germane substance, to which certain Faculties and Operations essentially belong; and in that sense it is adscriptive properly to God, Angels, the Souls of men, and spiritual Essences.[58]

The other type, equivalent to the interstitial void of

> atomism signifies a mere Negation of Corporiety, and so of corporeal Dimensions, and not any positive Nature capable of Faculties and Operations; and in this sense only is it congruous to the Dimensions of Space, which we have formerly intimated to be neither Active, nor Passive, but to have only a general Non-repugnancy, or Admissive Capacity, whereby it receives Bodies either permanenter, or transeunter.[59]

Charleton used the second kind of incorporeal to explain the occurrence of such phenomena as rarefaction and condensation while not invoking any kind of active, intervening quality within nature. Interparticulate void is simply another non-active component of the mechanical philosophy of nature, possessing no magical or mysterious qualities. This type of void does not share the theological problems of extracosmic void because it was created simultaneously with atoms rather than existing before creation.

Acknowledging the existence of an incorporeal entity to account for God, angels and the human soul allowed Charleton to avoid pure materialism. In The Immortality of the Soul (1659) he carefully established the existence of an

immaterial, immortal soul. His Christian piety could never accede to Epicurean materialism which considered the soul to be

> onely a certain Contexture or disposition of thinnest and subtilest Atoms, and so upon the change of that disposition by death is immediately dissolved, and those Atoms againe dispersed in the infinite Inanity of Space.[60]

Rather, Charleton claimed that

> the Soul is an Immortal Substance: and that its Immortality is not only credable by Faith, or upon Divine Authority, but also demonstrable by Reason, or the Light of Nature.[61]

Charleton sought to acknowledge the significance of both the spiritual and material realms, but wanted to ensure that each remained within its appropriate boundaries. Their respective importance was not diminished if they did not overlap. Reference to the existence of incorporeals in the spiritual realm could lend credibility to the existence of incorporeals in the material realm, even if the types of incorporeals in each realm were not identical. The strength of knowledge attained through faith gave credibility to knowledge gained through the use of reason alone. Using this approach, Charleton added support to the existence of void by making reference to the existence of souls, angels and God. The assumption that an incorporeal soul exists within a material body made it easier to acknowledge the existence of interstitial void within a material, non-active body. Therefore

> since there are some Natures purely Incorporeal

> and Immortal, and others purely Corporeal and Mortal; that these Extremes might not be without a Mean, nothing seems more congruous, than that there should be a certain sort of third Natures, so mixed and compound of both the others, as to be Incorporeal and Immortal, on one part, and Corporeal and Mortal, on the other. Again, whereas you imagine it absurd, that natures so extremely different should concur to constitute one Composition;...are not Heat, and Cold, white and black, as different each from other, as Immortal and Mortal; and yet you see, they are often conjoyned together, so as that a Middle or Third nature doth result from their union, as in particular, warme, from Heat and Cold, and Grey or browne, from white and black. Nay, there seems so much the less repugnancy betwixt Immortal and Mortal, Incorporeal and Corporeal natures; by how much they are the less Different and Incompossible because they are only as it were Disparate among themselves, and capable of conserving a whole nature.[42]

Charleton presented an English paraphrase of Gassendi's Christianized version of Epicurean atomism. It is not clear whether his attempt to maintain a distinction between metaphysics and physics while at the same time avoiding atheist complications was successful. Henry More, although committed to an atomist interpretation of natural phenomena, sought to modify Charleton's program by integrating theology within the materialism of the philosophy. In the next generation, Robert Boyle avoided direct support for Epicurean atomism, perhaps because it was still tinged with atheism. Charleton's influence extended to Isaac Newton, however, who defended atomism against the Cartesian version of the mechanical philosophy.[43]

## Notes - Chapter One

1. For biographical information on Charleton see Lindsay Sharp, "Walter Charleton's Early Life 1620-1659, and Relationship to Natural Philosophy in Mid-Seventeenth Century England, Annals of Science 30 (1973); 311-340 and Nina R. Gelbart, "The Intellectual Development of Walter Charleton," Ambix 18 (1971): 149-168; Robert Kargon, "Walter Charleton," Dictionary of Scientific Biography Vol. III ed. Charles C. Gillispie (New York: Charles Scribner's Sons, 1974), 208-210.

2. Sharp, 313.

3. Gelbart, 157. Charleton's conversion from Helmontism is also discussed in Walter Pagel, "The Reaction to Aristotle in Seventeenth Century Biological Thought," in Science, Medicine, and History: Essays on the Evolution of Scientific Thought and Medical Practice Written in Honour of Charles Senger ed. E.A. Underwood. 2 Vol. (London: Oxford U. Press, 1953), 497.

4. Walter Charleton, The Darkness of Atheism Dispelled by the Light of Nature. A Physico-Theological Treatise (London: 1652), Preface.

5. Charleton, Physiologia. Epicuro-Gassendo-Charletoniana: or a Fabrick of Science Natural, Upon the Hypothesis of Atoms (London: 1654; reprn., NY: Johnson Reprint Corp, 1966), Conclusion.

6. John Dryden wrote in the preface to Charleton's Chorea Gigantum, or the Most Famous Antiquity of Great Britain... (London, 1663);

> Nor are You, Learned Friend, the least renown'd;
> Whose Fame, not circumscrib'd with English ground,
> Flies like the nimble journeys of the Light;
> And is, like that, unspent too in its flight
> What ever Truths have ben, by Art, or Chance,
> Redeem'd from Error, or from Ignorance,
> Thin in their Authors, (like rich veins in Ore)
> Your Works unite, and still discover more.
> Such is the healing virtue of Your Pen,
> To perfect Cures on Books, as well as Men.

7. Charles Webster, "The College of Physicians: "Solomon's House" in Commonwealth England," Bulleton of the History of Medicine 41 (1967): 393-412; 396.

8. Charleton, Physiologia, 181.

9. Charleton, The Darkness of Atheism, 44.

10. Charleton, Physiologia, Conclusion.

11. Ibid, 134.

12. Ibid, 16.

13. Ibid, 17.

14. Ibid.

15. Ibid.

16. Ibid, 251.

17. Ibid, 252.

18. Ibid, 253.

19. Ibid.

20. Ibid, 426.

21. Ibid, 99, 111.

22. Ibid, 87.

23. Ibid, 89.

24. Ibid, 18.

25. Ibid.

26. Ibid.

27. Ibid.

28. Aristotle, Physics 214a 13-26.

29. Charleton, Physiologia, 22.

30. Ibid, 19.

31. Ibid, 341.

32. Maurice Mandelbaum, Philosophy Science and Sense Perception: Historical and Critical Studies (Baltimore: Johns Hopkins Press, 1964), 62.

33. Charleton, Physiologia, 23. Mandelbaum, Philosophy Science and Sense Perception: Historical and Critical Studies, Ch. 2. Mandelbaum states that such inference which draws conclusions about members of one set of observable entities and then uses

those conclusions to draw inferences about unrelated members of another set of unobservables was a common technique used by scientists in the past such as Boyle and Newton. This technique, referred to as transdiction, was founded on the belief "in 'vertical' as well as in 'horizontal' causation" and assumes consistent causation processes for members of both sets. (62) The problem with this manner of attaining knowledge is, "the question of how observed data can serve as grounds for inferences to objects or events which not only have not yet been observed, but which cannot in principle be observed." (63)

34. Charleton, Physiologia, 23.

35. Ibid, 19.

36. Charleton rejected Zeno's argument against motion by suggesting he promoted such an idea "as a new Paradox to gain some credit to Scepticism, of which he was a fierce Assertor" but that really, "no man did ever admit it to a competition with the Authority of his Sense." (Physiologia, 23).

37. Ibid, 24.

38. Ibid, 35. Charleton described the difference between naturally-occurring, interstitial vacuum and the vacuum artificially created within the pumps of experimenters such as Boyle. A coacervate vacuum does not occur in nature easily, not because nature abhors it, as the Aristotelians claim, but because the air particles are so fluid they always flow together, preventing a large vacuum. It is therefore, the air's "confluxibillity or fluidity" that prevents such a large vacuum from occurring.

39. Ibid.

40. Ibid, 344.

41. Ibid, 27.

42. Ibid, 29-30.

43. Ibid, 33.

44. Ibid, 31.

45. Ibid, 30.

46. See Alan Gabbey, "The Mechanical Philosophy and Its Problems: Mechanical Explanations, Impenetrability, and Perpetual Motion," in Change and Progress in Modern Science, ed. Joseph C. Pitt, (Dordrecht: D. Reidel, 1985) for a discussion of some of the

inconsistencies and conceptual difficulties inherent in a mechanical explanation of nature (9-84). Gelbart also discusses Charleton's awareness of the limitations of the mechanical philosophy (162).

47. Charleton, Physiologia, 263.

48. Ibid, 127.

49. For a presentation of the objections to ancient atomism which led to modifications of it see Robert Kargon, "Walter Charleton, Robert Boyle, and the Acceptance of Epicurean Atomism in England," Isis 55 (1964): 184-192. Kargon believes Charleton was successful in "removing many theological objections to atomism." (187).

50. Charleton, Darkness of Atheism, 46.

51. Charleton, Physiologia, 103.

52. Ibid, 126.

53. For a discussion of the controversy surrounding the possible existence of an infinite void existing before, and independently of God's creation of the world see Edward Grant, Much Ado About Nothing, 110-115.

54. Charleton, Physiologia, 126.

55. Ibid.

56. See Edward Grant, Much Ado About Nothing (Ch. 6) for a full discussion of the association between imagination and extracosmic space from antiquity to the seventeenth century.

57. Charleton, Physiologia, 68.

58. Ibid.

59. Ibid. This type of non-active vacuum could be either the naturally-occurring disseminated variety or the larger, artifically produced, coacervate vacuum found in the suction pumps of experimenters such as Boyle.

60. Charleton, Immortality of the Soul, 8.

61. Ibid. 185.

62. Ibid, 182-183.

63. For the influence of Charleton on Newton see Richard S. Westfall, "The Foundations of Newton's Philosophy of Nature," British Journal for the History of Science 1 (1962): 171-182.

# Chapter Two

## Henry More

## Making Room for a Spirit of Nature

Henry More (1614-1687), like Charleton, supported the mechanical philosophy. Unlike Charleton, however, More was interested in more than simply establishing the boundaries of the mechanical philosophy and sought to shift the basic parameters which defined atomism in order to encompass incorporeals such as the human soul and God more fully. Where Charleton accepted that such concepts would not be explained or understood within the mechanical philosophy and simply had to be accepted as matters of faith, More sought to incorporate them all within a single conceptual framework. More's version of the mechanical philosophy was therefore ontologically richer than Charleton's. His attempts to construct a coherent cosmology were directed by his theology, an enterprise which dominated his entire life.[1]

Educated at Christ's College, Cambridge, More received a Doctor of Divinity in 1660 and remained a fellow of that college for the rest of his life. A devoutly pious man, he was deeply influenced by neo-Platonist ideas because they emphasized the supremacy of spirit over matter. His interest in the innovative mechanical philosophy of nature

was recognized when he was made a member of the Royal Society in 1664, although he was never personally involved in carrying out any experiments. He was the only member of the group known as the Cambridge Platonists to receive this honour. The scholarly and intellectual attraction he had for the mechanical philosophy of nature was ultimately rooted in his desire to solidify Christian theology rather than in an interest to promote empiricism or experimentation.[2]

The atomist philosophy of nature was the ideal format for More to use in order to fulfill his theological agenda. The void not only explained certain natural phenomena but also provided a means to inject spirit into the operation of the world. More sought to remove distinctions between the mechanical and theological frameworks by considering that void, the correlative of atoms within the mechanical framework, conveyed a spirit of nature, the instrument of God, to inert matter particles. He actively sought to imbue vacuum with divine presence and action rather than simply extrapolate from one to the other as Charleton had done. More replaced the Aristotelian framework with a conceptual framework that directly accomodated his theological beliefs by including the concepts of God and the human soul as integral parts of natural philosophy. He linked the operations of the material world and God by means of the void. He tried to unify metaphysics and physics into

a coherent system.[3]

More's interest in developing such a system began with his attraction to Cartesianism, in the 1640's. Descartes's dualist philosophy which incorporated spirit although keeping it distinct from matter, was appealing to More because he sought to maintain a well-defined notion of spirit in his own philosophy of nature.[4] More recounted the "honour and pleasure of reading Des-Cartes" where he had "the first occasion of busying my thoughts upon this Subject."[5] He considered Descartes

> as a man more truly inspired in the knowledge of Nature then any that have professed themselves so this sixteen hundred years.[6]

Expressing his admiration in a letter written to Descartes in 1648, he stated that

> all the masters of the secrets of nature who have ever existed or now exist seem simply dwarfs or pygmies, when compared with your transcendent genius.[7]

More was attracted to the Cartesian distinction between matter and spirit because of its similarity to a neo-Platonic separation of the material from the ideal.[8] He assumed that such a distinction implicitly acknowledged the importance of incorporeals and therefore of God and an immortal soul. In addition, More approved of Cartesianism because it was a search for truth which began with theological assumptions.[9] He felt they would both

> meet together notwithstanding at last (and certainly not without Providence) at the same Goale, namely at the Enterance of the holy Bible,

> dedicating our joynt labours to the use and glory of the Christian Church.[10]

He derived physical theories of matter from metaphysical assumptions. A hierarchical system of knowledge, founded on the certainty of God's existence, provided certain knowledge in other areas, such as physics.[11] A starting-point founded on metaphysical principles led inevitably to an understanding of physical principles, for

> we shall first notice that we exist, insofar as our nature is that of a thinking thing; and at the same time we shall also notice both that God is, and that we depend upon Him, and that from a consideration of His attributes we can investigate the truth of the remaining things, since He is their cause.[12]

Assumptions about the nature of God moulded scientific reasoning. More considered Descartes' work to be an example of the integration of reason and religion since it combined a scientific approach with an interest in maintaining the reality of God.[13] Reason, in this system, did not seem to jeopardize religion.

Eventually, however, More became disillusioned with the Cartesian philosophy of nature and ultimately rejected it. By 1668 More considered Descartes' philosophy as merely, "an upstart conceit of this present Age."[14] Ironically, More based his rejection of Descartes' philosophy on the very aspect of Cartesianism which had initially attracted him, namely the significance given to incorporeals.[15] More's demand to ensure the existence of spirit in the world was

initially satisfied by the sharp distinction drawn by Descartes between spirit and body. More assumed that attention to this distinction gave equal importance to both entities. However, he came to doubt whether the Cartesian philosophy gave enough significance to incorporeal entities and grew increasingly suspicious of its rationalist approach which he thought would diminish the importance of religion.[16]

In the Cartesian system one could arrive at certain knowledge of the existence of matter, extended in length, breadth and depth. Descartes characterized matter solely in terms of extension and conceived it as, "the property it has of occupying space, not as an accident, but as its true form and its essence."[17] From this basic assumption the implication follows that space and matter are identical and, "have the same essential nature and thus are one and the same substance." [18] In the Cartesian system, therefore, it is entirely absurd to consider the possibility of a vacuum because space, which Descartes equated with extension, is equivalent to matter. Void as being, "a space in which there is absolutely no substance...[is therefore]... entirely contradictory."[19] More thought that this rejection of the existence of vacuum denied, or at least diminished, the presence and power of God

> for I argue that the divine extension lies between the sides of the vessel, and that your supposition on this point, that only matter of itself is extended, is weak.[20]

More could not accept Descartes' strict correlation of the geometrical with the physical, of extension with matter. He thought that by equating only matter with extension, Descartes exposed the inadequacies of his understanding of both matter and space and created insurmountable difficulties with the problem of motion. More shared Charleton's belief that accepting the plenist view of the world would make local motion impossible. If matter and space were both characterized by extension, with the world entirely full, movement could not occur except by the mutual replacement of one form of matter by another; a kind of material musical chairs. More importantly, such an identification did not include any incorporeal entities. More argued that

> God seems to be an extended thing, and angels: indeed, anything subsisting in itself would seem to be such; and this in such a way that the extension and the absolute essence of things would seem to be encompassed by the same limits, despite any differences in their essences.[21]

Considering only material entities to be extended seemed to imply atheism. If the most fundamental requirement for existence was extension, and only matter was extended, More worried that spiritual entities would then be considered non-existent. Explaining the world in purely materialist and mechanical terms would leave no room for God.

> He [God] is not that body, or matter, which your mind...has so skillfully turned into globules and striated particles.[22]

Therefore, "the concept of extended thing is broader than that of body"[23] since it was commonly accepted that God and other incorporeals did exist and could not be equated with material extension.[24]

Reacting against what he considered dangers in Cartesianism, More attempted to establish a philosophy of nature which recognized the significance of both material and non-material entities. He maintained that since matter moves <u>in</u> space, it cannot exist without space.[25] Furthermore, More sought to explain certain natural phenomena, such as gravity and magnetism, with which the mechanical philosophers had difficulty, by pointing to the importance of incorporeals as agents by which these phenomena were produced. A Cartesian world in which the equation of matter with mathematical extension produced a plenum was not only unsuccessful in explaining change and motion but left no place for incorporeals such as the human soul, or even God. Rather than rejecting the mechanical philosophy outright, More sought to modify the pure mechanism of Cartesianism so that incorporeals, and therefore God and the human soul, would be integral and necessary components of nature. He attempted to construct such a philosophy of nature within an atomistic framework, which acknowledged the existence of both matter and the void. More's modifications to this system and the analogies that he drew between the void and the human soul as well as

to a spirit of nature which emanated from God demonstrates his desire to integrate metaphysics and physics.

While More shared Descartes' desire to construct a unified system in order to describe reality accurately, in contrast to Descartes, he believed that such a program must incorporate both matter and spirit in the natural world. This approach involved a kind of vitalism reminiscent of neo-Platonism and the spiritualism of sixteenth century philosophers such as Bruno, who had contended that matter was an independent existent possessing its own inherent activity or form. They had considered matter to be "ensouled."[26] More was attracted to neo-Platonic ideas because they seemed to imply that the material substances of the world could be linked to God.

> [I] had also a zeal for the credit of the Platonists, whose imaginative presages I have often observed to hold a faithfull compliance with the severest Reason. And I think I have here demonstrated that their Fancy is not at all irrational in so usually comparing Form or Spirit to the radiant Light.[27]

Because Platonism considered immaterials to be such an important component of nature, More incorporated these elements into Cartesianism in order to create a philosophy of nature that would include what he considered to be all the important components of the universe. Because he saw

> that excellent philosophy of Plato's as the most consistent and coherent Metaphysical Hypothesis that has yet been found out by the wit of man,[28]

he felt that his, "interweaving of Platonisme and

Cartesianisme" would be

> making use of these Hypotheses as invincible Bulwarks against the most cunning and most mischievous efforts of Atheism.[29]

More also used Pythagorean ideas to argue for the existence of an incorporeal substance, emanating from God and spread throughout the world. According to Aristotle,

> the Pythagoreans, too, held that void exists and that it enters the world from the infinite air, the world inhaling also the void which distinguishes the natures of things, as if it were what separates and distinguishes the terms of a series. This holds primarily in the numbers; for the void distinguishes their nature.[30]

Other Greek philosophies, which considered spirit to be not only a kind of substance but also continually active in nature, influenced More as well.[31] For instance, the Stoic notion of the pneuma lent credence to More's idea of a spirit of nature. Stoicism considered the universe to be an organic whole, alive with forces which both emanated from a divinity and directed the material world.[32] Additional influences on More came from Jewish thought about space. In describing spirit, More stated that it is extended, indivisible, and that this

> immense internal place or space really distinct from matter which we mentally conceive is...a kind of confused and general representation of the divine essence or essential presence...[is] wonderfully consistent with the teaching of the Cabbalists.[33]

More adopted aspects of each of these philosophies to formulate a link between his metaphysics and physics. He

relied on them to support his theory that the void of the mechanical philosophy of nature is the receptacle for spirit. In this way he used the void to explain not only certain natural phenomena but also God's activity in nature.

In order to construct a philosophy of nature that incorporated both corporeal and incorporeal entities, More had to provide evidence for the existence of such incorporeals. First, More proposed the existence of various types of incorporeals

> as for example that of God, of Angels, of the Souls of Men and Brutes, and of the...Seminal Forms of things.[34]

He, like Charleton, proved the existence of these various types of incorporeals by utilizing two distinct approaches, one from within a theological framework and the other from within the mechanical philosophy. He hoped to establish the existence of incorporeals from within both frameworks, thereby presenting a unified cosmology. Unless such proofs came from both frameworks, the result would be less effective.

More wanted to argue against, "all those so confident Exploders of Immaterial Substances,"[35] such as Hobbes and Descartes and felt that, "the nature of a Spirit is as conceivable and easy to be defined as the nature of any thing else."[36] Furthermore, denying the existence of incorporeals would imply that

> it is impossible that there should be any God, or Soul, or Angel, Good or Bad; or any Immortality or

> Life to come. That there is no Religion, no Piety nor Impiety, no Vertue nor Vice, Justice nor Injustice, but what it pleases him that has the longest Sword to call so.[37]

More thought that refusing to accept the existence of incorporeals within the framework of the mechanical philosophy would influence one's acceptance of incorporeals within the spiritual framework. Therefore, he argued, denying the void would lead to denial of all other incorporeal entities such as angels and even God since, "that which is no-where is not at all."[38] Even though More was aware that some "inconsiderable Philosophers" would "hoot at it, and deride it as much as their Follies please"[39] he nonetheless set out to prove the existence of incorporeals.

More anchored his proofs for the existence of incorporeals firmly within a theological framework. He assumed that belief in God, as an intangible and invisible entity, "Infinite and Uncreated," confirmed the existence of incorporeals. Using the standard argument from design, More asked

> how is it conceivable that any one particle of Matter or many together (there not existing yet in Nature any Animal) can have the Idea impressed of that Creature they are to frame?[40]

He simply assumed that

> Wherefore the ordinary Phaenomena of Nature being guided according to the most Exquisite Wisdome imaginable, it is plain that they are not the Effects of the mere motion of Matter, but of some Immaterial Principle.[41]

Another proof for the existence of incorporeals that was also founded in theological assumptions was the occurrence of apparitions, angels and ghosts. Pointing to instances of levitation More asked, "How could an arm of mere Air or Aether pull at another man's hand or arm."[42] Concluding that such behaviours could not be accomplished by "a mere Congeries of Atomes," More stated that "there must be some other substance in these Spectres of Air or Aether."[43]

More's theological assumptions demanded the existence of incorporeals. In a letter to Robert Boyle, More declared himself as "so much of a stickler for the support of natural religion," that he was convinced that

> the phaenomena of the world cannot be solved merely mechanically, but that there is the necessity of the assistance of a substance distinct from matter, that is, of a spirit, or being incorporeal[44]

The immortal human soul was another of the types of spirit that More hoped to confirm by means of natural philosophy. Spirit was a necessity in any philosophy of nature since its absence would violate all basic Christian assumptions. More thought that

> the greatest and grossest Obstacle to the belief of the Immortality of the Soul, is that confident opinion in some, as if the very notion of a Spirit were a piece of Non-sense and perfect Incongruity in the conception thereof.[45]

Acknowledgement of the soul was, in More's program, a corollary of spirit in general.

More strengthened his theory for the existence of incorporeals by arguing from within the mechanical framework. He indicated problems within the mechanical philosophy that he believed could not be resolved without appealing to the existence of vacuum. Purely mechanical explanations did not always adequately explain natural phenomena. For instance

> the phaenomenon of Gravity, is it not perfectly repugnant to that known mechanicall Principle[46]

Other phenomena not fully accounted for by purely mechanical explanations included various mental operations such as sense, memory, "mathematical and logical conceptions," and free will.[47]

Another aspect of the natural world not explained successfully by mechanism alone was magnetism. More pointed out that

> this mystery Des-Cartes has explained with admirable artifice as to the immediate Corporeal causes thereof, to wit, those wreathed particles which he makes to pass certain screw-pores in the Load-stone and Iron.[48]

More, however, considered the Cartesian explanation inadequate and that

> the efformation of these particles is above the reach of the mere Mechanical powers in Matter...[and that]...mere corporeal motion in Matter, without any other guide, would never so much as produce a round Sun or Star.[49]

Another proof for the existence of incorporeals came from

> the evidence of Externall Objects of Sense, that is, the ordinary Phaenomena of Nature, in which there is discoverable so profound Wisdome and

> Counsell, that they could not but conclude that the Order of things in the world was from a higher Principle then the blind motions and jumblings of Matter and mere Corporeal Beings.[50]

A purely mechanical explanation of such phenomena as these was "mear precarious opinion,"[51] for

> there is a Principle in the World that does tug so stoutly and resolutely against the Mechanick laws of Matter.[52]

More thought that proving the existence and importance of this incorporeal 'principle' in the physical operations of the universe would reinforce his religious beliefs.

More's attempt to prove the existence of incorporeals depended upon two assumptions. Firstly, it was assumed that incorporeals as well as material substances had their own extension rather than being simply co-extensive with matter. Secondly, matter was considered inert, with no property of self-activity. These two assumptions were compatible with both the theological and mechanical frameworks which More wanted to integrate. The bridge used by More to link these two realms was the notion of vacuum.

Cartesianism equated only material substance with extension, thereby eliminating the existence of any sort of extended incorporeal 'substance.' In order to make his idea of the importance of spirit in the workings of the universe plausible, More presented it as having characteristics similar to those of matter. He thought that by giving the same characteristic of extension to both matter and spirit,

he gave them both a reality.[53] Since More considered extension a necessary requirement for existence, both matter and spirit had necessarily, to be extended. More believed that

> it being of the very essence of whatsoever is, to have Parts or Extension in some measure or other. For, to take away all Extension, is to reduce a thing onely to a Mathematical point, which is nothing else but pure Negation or Non-entity; and there being no medium betwixt extended and not-extended, no more then there is betwixt Entity and Non-entity, it is plain that if a thing be at all, it must be extended. And therefore there is an Essential Extension belonging to these indiscerpible particles of Matter; which was the other Property which was to be demonstrated.[54]

An incorporeal spirit could be real only if it were extended. It was required, "that there ever was, is, and ever will be an immovable extension distinct from that of movable Matter."[55]

More supported this theory by appealing to the vacuum experiments. He wrote to Boyle that he believed "myself most firmly to have concluded from these experiments" that there is "a substance distinct from matter, that is, of a spirit, or being incorporeal."[56] More wondered why if, "it be so demonstratively concludible, as Des-Cartes would bear us in hand," that the world was in fact a plenum there "have made so many Disputes and try'd so many Experiments whether there be any Vacuum or no."[57]

Using a thought experiment, More showed that something intangible could be extended. He suggested consideration of

a cylinder with "a Line drawn from the top of the Axis of that Cylinder to the Peripherie of the Basis." When the cylinder turns, a cone is described, not through the cylinder but with it, indicating an independent reality for the cone.[58] More used this example to demonstrate the existence of an intangible entity co-existent with a tangible entity and that it

> evidently demonstrates the existence of the ancient Democritish Vacuum, and withall that Extension and Matter are not convertible terms; for which yet Cartesius so much contends.[59]

This incorporeal spirit, which More located in the atomist vacuum is quite real, for

> there is more then an imaginary Being there. And the ancient Atomists call this Vacuum..., the intangible nature; which is a sign they thought it some real thing.[60]

More found further theoretical support for the significance of non-corporeal entities from the Pythagoreans who considered incorporeals to be real. More referred to Aristotle who

> somewhere in his Physicks expressly declares of the Pythagoreans, that they held there was a Vacuum, from an infinite spirit that pervades Heaven or the Universe, as living and breathing in virtue thereof. As if this Pythagorick Vacuum were that to the Universe which the Aire is to particular Animals, that wherein and whereby they live and breathe. Whence it is manifest the Pythagoreans held it no imaginary Being...unless you will flinch from the Dictates of your so highly-admired Des-Cartes, forasmuch as this Vacuum is extended, and measurable, and the like, it must be a Reality; because Non entis nulla est Affectio...From whence it seems evident that there is an extended Substance far more subtile then Body, that pervades the whole Matter of the

Universe.[61]

More's argument for the existence of incorporeals rested on a second assumption, that matter is inert, possessing no property of self-activity. It is only through the inactivity of matter that the notion of incorporeals, and thus of God, could have physical significance.[62] Since

> matter...is inert and stupid of it self; then it must be moved from some other, and thus of necessity we shall be cast upon a God, or at least a Spiritual Substance actuating the Matter.[63]

More again pointed to "that noble and ingenious Gentleman's Experiments of his Airepump"[64] to illustrate the inactivity of matter, and therefore implicitly, the activity of some immaterial substance. According to More, Boyle's vacuum experiments showed that such 'directive Activity' did not exist within the particles of matter comprising the air itself since the air particles were removed by the mechanical action of the air pump rather than acting to equalize their numbers and prevent the evacuation. This fact, for More,

> is a Demonstration that the Impetus of Motion in all Matter is blinde and necessary, and that there is no Matter at all that is free and knowing, but moves and acts of it self (if undirected by some other Immaterial Principle) according to the mere Mechanical Laws of Motion.[65]

More rejected Boyle's interpretation which explained the difficulty of opening the valve on his evacuated receiver in terms of the elastic nature of air. Where Boyle focused on a material, mechanical explanation of these experimental

phenomena, More explained the pressure exerted after the pump was evacuated in terms of the incorporeal spirit of nature acting on the air particles.

Motion, then, and all natural phenomena are produced by the action of an incorporeal spirit upon inert matter. Such a spirit of nature is responsible for those actions "which cannot be resolved into any Mechanical Principle, though some have ingeniously gone about it."[66] The spirit of nature, which is the vehicle through which More can inject incorporeals is

> 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.[67]

This spirit of nature

> remands down a stone toward the Center of the Earth as well when the Earth is in Aries as in Libra, keeps the Water from swilling out of the Moon, curbs the matter of the Sun into roundness of figure, which would otherwise be oblong, restrains the crusty parts of a Star from flying apieces into the circumambient Aether,...every where directs the magnetick Atomes in their right Rode; besides all the Plastick services it does both in Plants and Animals.[68]

Furthermore, this spirit had the attributes of

> Self-motion, Self-penetration, Self-contraction and dilatation, and Indivisibility, by which I mean Indiscerpibility: to which I added Penetrating, Moving and Altering the Matter...A substance Indiscerpible, that can move it self, that can penetrate, contract, and dilate it self, and can also penetrate, move, and alter the Matter.[69]

The atomist philosophy of nature required interstitial void to explain such natural phenomena as condensation and rarefaction. In More's version of the mechanical philosophy it was the spirit of nature, residing within interparticulate void, which was responsible for these actions. Both Charleton and More advocated theories of matter necessitating void in order to explain such natural phenomena adequately. However, More went beyond the limits established by Charleton, who clearly distinguished between types of incorporeals. The type of void used by Charleton within the parameters of his mechanical philosophy was inactive, responding only to material shifts between atoms. He was careful not to endow this void with any spiritual activity although he did rely on the acceptance of incorporeals within the theological framework to provide evidence for the existence of this type of void. More, in contrast, did not distinguish between types of incorporeals. This approach allowed him to place an incorporeal spirit, emanating from God, within the void of the atomists.

However, characterizing interparticulate void as the vehicle for divine qualities such as self-motion risked accusations of pantheism. Therefore, More's spirit of nature, and hence the interparticulate void, was not identical with God. Rather, "we may look upon this Spirit of Nature as the great Quartermaster-General of Divine

Providence."[70] A hierarchy of spirits in the universe emanates from God.[71] That God is not to be directly found within the spirit of nature is further illustrated by the irregularities and mistakes found within nature. If this spirit were truly God then "there would be no Defects nor Monstrosities in the generation of Animals."[72]

Giving the spirit of nature the characteristic of spissitude further showed that God could not be directly located within it. Spissitude is, according to More, "the redoubling or contracting of Substance into less space then it does sometimes occupy."[73] It would clearly be a contradiction for God to contract or expand in such a fashion since the divinity is everywhere, at all times, and cannot be described by or subjected to laws operative in the natural world.

More tried to establish the existence of incorporeals, which would then lend credence to the existence of God, angels and an immortal soul, not only through theological assumptions but by reference to aspects of the mechanical philosophy. For More a purely mechanical philosophy of nature, relying only on material atoms moving within a void, was inadequate, not only because it did not successfully explain certain natural phenomena, but also because it did not include basic theological assumptions. According to More, the mechanical philosophy was not incompatible with the demands of religion as long as a notion of spirit was

incorporated within it. By including spirit or incorporeals within the mechanical philosophy "there is the double Pleasure...to the Rational and Religious."[74] More supported atomism, "before any other" because

> this mode of Philosophy is the most useful for the best ends, and serves to support the main parts of natural Religion the best; namely the Existence of God, of Genii or Angels, and the Immortality of the Soul.[75]

More's interest in the void therefore, did not simply result from an increased interest in experimental natural philosophy but expressed his attempt to ensure the dominance of a philosophy of nature that maintained not only basic theological assumptions of the supremacy of God but also avoided the dangers of Cartesian and Hobbesian materialism. Void became important in this program because it lent credence to a belief in immaterialism and therefore in the immortality of the soul and the activity of God in the natural world.

More believed he swept away materialist undercurrents within mechanism by putting a spirit in the void and making it the instrument through which a divine power operated. In this way, More thought he was linking physics and metaphysics. This allowed him to maintain the importance of theology while also improving on the mechanical philosophy by providing explanations for phenomena in nature, such as magnetism, that could not be explained adequately by a purely mechanical interpretation.

Many scholars have suggested that More's incorporation of spirit in physics influenced his successors, particularly Isaac Newton. Newton's rejection of a material aether as the causal explanation for gravity led him to postulate instead, God as the cause. For

> God is as far as vacuum extends, but he, being a spirit and penetrating all matter, can be no obstacle to the motion of matter; no more than if nothing were in its way.[76]

Newton's ideas concerning absolute space and force were certainly developed in part through consideration of More's theories concerning the existence of incorporeals and the transference of divine power through these incorporeals into the matter of the universe.[77] However, although both men developed theories using God to explain the mechanics of motion, each arrived at this theory from a different standpoint. Both More and Newton focused on the same fundamental issues relevant in order to construct a coherent cosmology. More chose to build his philosophy of nature upon basic theological assumptions. The demands imposed upon his theoretical reasoning by theology remained dominant. Theological constraints moulded theoretical considerations. Newton was not immune from making theological assumptions in his construction of scientific theory.[78] However, in the Principia, he derived his laws of motion from mathematical, empirical and physical principles, such as the principle of inertia, and built from these to a

theological conclusion. Concepts about God followed inevitably from scientific reasoning instead of the other way around.

## Notes - Chapter Two

1. For a discussion of the relationship in the seventeenth century between philosophies of nature and perceptions about the relationship between God and nature see Margaret J. Osler, "Descartes and Charleton on Nature and God," Journal of the History of Ideas 40 (1979):445-456. Those who emphasized God's free will supported an empirical natural philosophy, while those who emphasized God's intellect promoted a rationalist approach to the study of nature. This theory is also disucssed by the same author in, "Providence and Divine Will in Gassendi's Views on Scientific Knowledge," Journal of the History of Ideas 44 (1983): 549-560. The argument that More's natural philosophy was moulded by his religion is also presented in Max Jammer, Concepts of Space. The History of Theories of Space in Physics, 2nd Ed., (Cambridge: Harvard University Press, 1969), 40-52.

2. Biographical information about Henry More can be found in William Austin, "Henry More," Dictionary of Scientific Biography, Vol. IX, ed. Charles C. Gillispie (New York: Charles Scribner's Sons, 1974), 509-510; Aharon Lichtenstein, Henry More. The Rational Theology of a Cambridge Platonist (Cambridge: Harvard University Press, 1962), Ch. 1; Flora I. MacKinnon, Philosophical Writings of Henry More (New York: AMS Press, 1925), Introduction.

3. Robert A. Greene, "Henry More and Robert Boyle on the Spirit of Nature," Journal of the History of Ideas 23 (1962): 541-474 says that More promoted science because it would "aid in the apologetic defense of deity." (453).

4. G.P.H. Pawson, The Cambridge Platonists and their Place in Relgious Thought (London: Society for Promoting Christian Knowledge, 1930), 60.

5. Henry More, The Immortality of the Soul (London: 1659; repr., New York & London: Garland Pub., 1978), the Epistle Dedicatory.

6. Henry More, An Appendix to the Defence of the Philosophick Cabbala (London: 1662; repr., New York & London: Garland Pub., 1978), Ch. I, 104.

7. More to Descartes (December 11, 1648) as quoted in L. Cohen, "Descartes and Henry More..." Annals of Science 1 (1936): 48-61.

8. Flora I. MacKinnon ed. Philosophical Writings of Henry More (New York: AMS Press, 1925), xviii.

9. F.J. Powicke, The Cambridge Platonists. A Study (New York: Hildesheim, 1970), 156.

10. Henry More, Antidote against Atheism (London: 1653; repr., New York & London: Garland Pub., 1978), Preface, xii.

11. For a general overview of Descartes' program see Frederick Copleston, A History of Philosophy, Vol. IV, (New York: Image Books, 1963), Ch. II-VI; Herbert Butterfield, The Origins of Modern Science. 1300-1800 (Thetford, Norfolk: Lowe & Brydone, 1957; repr., Toronto: Clarke, Irwin & Co. Ltd., 1977), Ch. VI.

12. René Descartes, Principles of Philosophy, trans. Valentine R. Miller and Reese P. Miller (Paris, 1647; reprnt; Dordrecht: D. Reidel Pub. Co., 1983), Bk. I, 75.

13. Amos Funkenstein, "The Body of God in 17th Century Theology and Science," in Millenarianism and Messianism in English Literature and Thought. 1650-1800, ed. Richard Popkin, (Brill: Leiden, New York, 1988), 168. See also Margaret J. Osler, "Descartes and Charleton on Nature and God," Journal of the History of Ideas 40 (1979): 450, who states that Descartes' "criterion of accepting only clear and distinct ideas as true rested squarely on God's existence."

14. Henry More, The Divine Dialogues (London: 1668), 95.

15. For an outline of More's objections to Cartesianism see John T. Baker, An Historical and Critical Examination of English Space and Time Theories from Henry More to Bishop Berkely (New York: Sarah Lawrence College, 1930), Ch. I, II.

16. Powick, 156. For a presentation of More's criticism of Descartes see also E.J. Burtt, The Metaphysical Foundations of Modern Science (New York: Anchor, 1954; first pub. 1924), 135-148.

17. René Descartes, Le Monde trans. Michael S. Mahoney (New York: Abaris Books, 1979), 57.

18. Descartes, Principles, Bk. II, 11.

19. Ibid, 16.

20. Henry More to Descartes (December 11, 1648) as quoted in The Concepts of Space and Time. Their Structure and Their Development, ed. Milic Capek, (Dordrecht: D. Reidel Pub. Co., 1976), 87.

21. Henry More to Descartes (December 11, 1648) as quoted in The Concepts of Space and Time. Their Structure and Their

Development, ed. Milic Capek, (Dordrecht: D. Reidel Pub. Co., 1976), 85.

22. Ibid.

23. Ibid.

24. Ernst Cassirer remarked that "...it is only through being in space that God can embrace and affect the being of all things. On the basis of this reasoning More can deliberately boast that he has brought God back into the world by the same gate through which Descartes took Him out." The Platonic Renaissance in England, trans. J.P. Pettegrove, (New York: Gordian Press, 1970), 150.

25. Alexander Koyré, From the Closed World to the Infinite Universe, 127. An outline of More's program is also presented in Michael Boylan, "Henry More's Space and the Spirit of Nature," Journal of the History of Philosophy 18 (1980): 395-405.

26. Ivor Leclerc, The Nature of Physical Existence (London: Geo. Allen & Unwin Ltd., 1972), 200.

27. Henry More, Immortality of the Soul, Preface, 7.

28. Henry More, as quoted in MacKinnon, xxvi.

29. Henry More, A Collection of several Philosophical Writings (London: 1662; repr., New York: Garland Pub., 1978), vi.

30. Aristotle, Physics Bk. IV, 213b: 22-27. See Leclerc, The Nature of Physical Existence, 178, for a discussion of the necessity of void in order to accomodate a notion of discreteness and therefore of plurality and ultimately for the existence of separate bodies.

31. The concept of spirit as substance was commonplace in the seventeenth century. Arguments existed over whether or not spirit was active in nature.

32. Funkenstein, 157.

33. Henry More, Opera, as quoted in Brian P. Copenhaver, "Jewish Theologies of Space in the Scientific Revolution...", 524.

34. Henry More, Immortality of the Soul, Bk. I, Ch. IV, 23. The existence of these incorporeals, except the notion that 'brutes' possessed souls, was commonly accepted in the seventeenth century.

35. Ibid, Preface, 5.

36. Henry More, Antidote against Atheism, Bk. I, Ch. IV, 15. Although Descartes did not deny the existence of incorporeals, More accused him of just that because Descartes did not give incorporeals extension.

37. Henry More, Immortality of the Soul, Bk I, Ch. IX, 36.

38. Henry More, Divine Dialogues, 137.

39. Henry More, Immortality of the Soul, Bk I, Ch. XIV, 57.

40. Ibid, Bk. I, Ch. XII, 49.

41. Ibid.

42. Henry More, Divine Dialogues, 93.

43. Ibid.

44. More to Boyle (December 4, 1665), R. Boyle, Works Vol. 6.514-515. Allan Gabbey disputes this date and puts it instead at 1671. See Thomas H. Jobe, "The Devil in Restoration Science: The Glanvill-Webster Witchcraft Debate," Isis 72 (1981): 343-356 for a full discussion of how reference to ghosts and witches strengthened the reconciliation between the new experimentalism and Anglican theology; also Simon Schaffer, "Occultism and Reason," in Philosophy, Its History and Historiography, ed. A.J. Holland, (Dordrecht: D. Reidel, 1985), 117-143.

45. Immortality of the Soul, Bk. I, Ch. III, 21. More is perhaps being directly critical of Hobbes who stated that,

> nothing can be powred, or breathed into any thing, but body; and that, extension is body; that phantasmes are spirits. (Leviathan, Part I, Ch. 5)

46. Henry More, Divine Dialogues, 41.

47. The occurrence of these phenomena indicated, for More, that,

> matter is utterly uncapable of such operations as we find in ourselves, and that therefore there is Something in us Immaterial or Incorporeal.(Immortality of the Soul, Bk. II, Ch. II, 66.)

48. Henry More, Immortality of the Soul, Bk. III, Ch. XII, 196.

49. Ibid.

50. Ibid, Bk. I, Ch. X, 40.

51. Henry More, Enchiridion Metaphysicum (London: 1671), XXVIII, 20. Ch. 27-28 of this work are translated in Joseph Glanvil, "The Easie, True, and Genuine Notion and Consistent Explication of the Nature of a Spirit," in Saducismus Triumphatus (London: 1681).

52. Henry More, Antidote against Atheism, Bk. II, Ch. II, 46.

53. J.T. Baker, An Historical and Critical Examination of English Space and Time Theories from Henry More to Bishop Berkeley. (New York: Sarah Lawrence College, 1930), 6.

54. Henry More, Immortality of the Soul, Preface, 3.

55. Henry More, Divine Dialogues, 103.

56. More to Boyle, (December 4, 1665), in R. Boyle, Works Vol. 6.515.

57. Henry More, Divine Dialogues, 95. More did not understand that Boyle, with these experiments, was not trying to prove or disprove the existence of vacuum. More misinterpreted Boyle's experiments to serve his own ends. What Boyle saw as evidence for the spring of the air, More interpreted as evidence for the existence of a spirit of nature. Steven Shapin and Simon Schaffer say that More "rewrote Boyle's experimental reports for his own purposes" which was to use "natural philosophy as a weapon in theology." Leviathan and the Air-Pump. Hobbes, Boyle and the Experimental Life (Princeton: Princeton University Press, 1985), 212.

58. Henry More, Divine Dialogues, 101-103. See also Brian P. Copenhaver, "Jewish Theologies of Space in the Scientific Revolution: Henry More, Joseph Raphson, Isaac Newton and their Predecessors, Annals of Science 37 (1980): 489-548.

59. Henry More, Divine Dialogues, 103.

60. Ibid, 105. Contemporaries of More's also equated the notion of this incorporeal spirit to the atomist vacuum. The reviewer of More's Enchiridion Metaphysicum believed that More, "labours to shew, that that Space or Internal Place is really distinct from Matter, and an Incorporeal Spirit..." Philosophical Transactions of the Royal Society VI (1671) No. 72, 2183.

61. Henry More, Divine Dialogues, 105-106.

62. Keith Hutchison, "Supernaturalism and the Mechanical Philosophy," History of Science 21 (1983): 297-333, 297. This idea is also argued in John Henry, "Occult Qualities and the Experimental Philosophy: Active Principles in Pre-Newtonian Matter Theory," History of Science 24 (1986): 335-381.

63. Henry More, Antidote against Atheism, Bk. II, Ch. I, 38.

64. Ibid, Bk. II, Ch. II, 43.

65. Henry More, Antidote against Atheism, Bk. II, Ch. II, 44.

66. Henry More, Immortality of the Soul, Bk, III, Ch. XII, 193.

67. Ibid.

68. Henry More, Collection of Philosophical Works, Preface, xv.

69. Henry More, Immortality of the Soul, Bk. I, Ch. V, 25. A similar description of spirit is provided in Antidote against Atheism where More states that,

> I conceive the intire Idea of a Spirit in generall, or at least of all finite created and subordinate Spirits, to consist of these several powers or properties, viz. Self-penetration, Self-motion, Self-contraction and Dilatation, and Indivisibility...the power of Penetrating, Moving, and Altering the Matter. (Bk. I, Ch. IV, 15-16).

70. Henry More, Immortality of the Soul, Bk. III, Ch. XII, 203.

71. Amos Funkenstein, Theology and the Scientific Imagination from the Middle Ages to the Seventeenth Century (Princeton: Princeton University Press, 1986), 79. This concept of a hierarchy of spirits being characteristic of Anglican theology is also auggested by Thomas H. Jobe, "The Devil in Restoration Science..."

72. Henry More, Immortality of the Soul, Bk. II, Ch. X, 102.

73. Ibid, Bk. I, Ch. II, 20.

74. Ibid, Preface, 13.

75. Ibid, Preface, 13.

76. as quoted in B.J.T. Dobbs, "Newton's Alchemy and his 'Active Principle' of Gravitation," Newton's Scientific and Philosophical Legacy, ed. P.B. Scheurer and G. Debrock, (Dordrecht: Kluwer Academic Pub., 1988), 59.

77. For the importance of More on Newton's thought see J.E. McGuire, "Existence, Actuality and Necessity: Newton on Space and Time," Annals of Science 35 (1978): 463-508. The influences contributing to Newton's physics are also discussed in B.J.T. Dobbs, "Newton's Alchemy and his 'Active Principle' of Gravitation," in Newton's Scientific and Philosophical Legacy,

ed. P.B. Scheurer and G. Debrock, (Dordrecht: Kluwer Academic Pub., 1988), 55-80.

78. Evaluations of Newton's work have shifted over the past thirty years and now recognize the importance of alchemy and other ancient sources which helped to confirm Newton's notion about God's omnipresence. See B.J.T. Dobbs, "Newton's Alchemy and his 'Active Principle' of Gravitation," in Newton's Scientific and Philosophical Legacy ed. P.B. Scheurer and G. Debrock (Dordrecht: Kluwer Academic Publishers, 1988), 55-80 for a discussion of some of the ancient influences on Newton's scientific theories. For a discussion of the importance of a universal, vital agent in Newton's mechanism see also B.J.T. Dobbs, "Newton's Alchemy and his Theory of Matter," Isis 73 (1982): 511-528. The importance of the relationship between Newton's theories of space and time and God is discussed in J.E. McGuire, "Existence, Actuality and Necessity: Newton on Space and Time," Annals of Science 35 (1978): 463-508.

## Chapter Three

## Robert Boyle

## Void as a Useful Hypothesis

Robert Boyle (1627-1691), was a prominent supporter of the mechanical philosophy in the generation following Charleton. An interest in medicine provoked his study of chemistry and he became well-known for his studies of chemical reactions as well as his research into the nature of air. Boyle's name is still current in the scientific law bearing his name. His pneumatical experiments also examined the importance of air for respiration and sound.

Born into a large, aristocratic family Boyle received most of his education from private tutors. As a teenager, he travelled extensively through Europe where he became familiar with the scientific work of Descartes and Galileo. He eventually settled in London and became one of the most prominent natural philosophers of the Royal Society. Boyle dedicated himself to a life investigating the world around him and promoted an empirical and experimental approach to such investigations. A devoutly pious Anglican, Boyle also sought to ensure the supremacy of Christian theology.[1]

Given the extensive nature of Boyle's experiments with vacuum pumps, one could assume that he was continuing the work of Charleton and More to prove the existence of vacuum

or to give it some spiritual significance.[2] However, Boyle refused either to assert or to deny the existence of vacuum except when he was arguing against those, like Henry More, who proposed theories that Boyle could not accept. Even then, he used void only as a device that was useful for explaining such phenomena as rarefaction. Rather than regarding it as an actually-existing entity, Boyle referred to the void indirectly as the absence of matter. This was the only way in which Boyle could reconcile a concept of void, although necessary to explain certain observations, to his philosophy of nature which accepted only mechanical explanations in terms of matter in motion. Unobservables, such as corpuscles, could be reconciled to this philosophy through transdiction. This form of analogous inference is evident in his description of the famous Strasbourg clock which operated by the motions of unobservable gears and springs.[3] Assuming similar, mechanical operations in nature, Boyle argued that modifications to the configuration of unobservable corpuscles were the ultimate terms of explanation of natural phenomena. He humbly accepted that different explanations might be just as plausible as long as they were mechanical. However, Boyle preferred to leave phenomena unexplained rather than propose non-mechanical explanations.[4] Therefore, Boyle could not support the existence of an entirely immaterial entity that did not have such primary characteristics as shape and size.

Furthermore, Boyle's reluctance to acknowledge the actual existence of void perhaps indicated the failure of Gassendi and Charleton to convince seventeenth century natural philosophers that atomism could be cleansed of the atheism associated with it since antiquity.[5] His refusal to support atomism pointed to his fear of materialism. Any endorsement of the void could also be mistaken for support of More's 'spirit of nature' which Boyle considered to be a dangerous and unnecessary deification of nature.

Boyle, like Charleton and More, chose to endorse a mechanical philosophy of nature, but did not openly choose between a plenist or vacuist version of this philosophy unless threatened by a philosophy opposed to a mechanist interpretation. This position explains his support of atomism, and vacuum, only when arguing against More's injection of a spirit of nature into the void. When not faced with such direct opposition, Boyle argued for "corpuscularianism", a mechanical philosophy of nature that did not address the question of the void. Both Charleton and More invoked the void because they believed it provided the most adequate explanation of certain natural phenomena. At the same time, they supported it because it was, although not always explicitly, compatible with their theological assumptions about the importance of incorporeal entities in the world. Therefore, they both viewed the void as a positive means by which to reconcile theology and natural

philosophy.

However, Boyle avoided overt acknowledgement of vacuum precisely because he feared it might prevent any such reconciliation by leading instead to deism or outright atheism. He chose, therefore, to endorse a philosophy of nature founded entirely on the interaction of material entities only. He maintained theological assumptions not in the every-day operation of these material entities but by acknowledging their initial creation and design. Therefore, although he did not appear to make direct theological inferences through his natural philosophy, Boyle, nonetheless, presented a mechanical philosophy that was moulded by theological and metaphysical concerns.[6] His avoidance of the void indicated his reluctance to inject spiritual entities into nature, entities which he thought would diminish the need for an omnipotent God.

Boyle was aware of the tensions between the various philosophies of nature vying for dominance at that time, and, like Charleton and More, he chose a mechanical philosophy of nature but, unlike them, he did not emphasize the necessity of vacuum.[7] In establishing his own program, Boyle first had to discredit the traditional and competing programs. Several philosophies about how the world worked stood as alternatives to the traditional Aristotelian theory. Among these were the mechanical philosophy of nature as proposed by Descartes and Gassendi and the

chemical philosophy as proposed by Paracelsus. Each advocated a particular view of the universe that was linked to metaphysical notions. The acceptance or rejection of each world-view did not rest merely on the supposed validity of their theories of nature but on how compatible each theory was to theological presuppositions.[8]

In The Sceptical Chemist, Boyle described the Hermetic as well as the Peripatetic traditions and pointed out the discrepancies each had in explaining natural phenomena. He considered that

> there are a thousand phenomena in nature, besides a multitude of accidents relating to the human body, which will scarcely be clearly and satisfactorily made out by them that confine themselves to deduce things from salt, sulphur, and mercury, and the other notions peculiar to the chymists...[9]

Boyle wanted to draw "the chymists' doctrine out of their dark and smokie laboratories, and...into the open light."[10] He professed his "unsatisfiedness not only with the peripatetic, but with the chymical doctrine of the primitive ingredients of bodies,"[11] and suggested that the

> dialectical subtelties, that the schoolmen too often employ about physiological mysteries, are wont much more to declare the wit of him that uses them, than increase the knowledge or remove the doubts of sober lovers of truth.[12]

Furthermore, "things that have been magisterially taught and confidently believed among the followers of Aristotle are errors or mistakes."[13] Central to Boyle's criticism of Aristotelianism was the use of

> certain substantial forms and real qualities; (the former of which are acknowledged to be very abstruse and mysterious things, and the latter are many of them confessedly occult)...[14]

Boyle found that

> these uninstructive terms do neither oblige nor conduct a man to deeper searches into the structure of things, nor the manner of being produced, and of operating upon one another; and consequently are very insufficient to disclose the exquisite wisdom, which the omniscient Maker has expressed in the peculiar fabrics of bodies, and the skilfully regulated motions of them, or of their constituent parts...[15]

Explaining natural phenomena in terms of such 'indeterminate agents' was inadequate for Boyle because

> though they may in certain cases tell us things, yet they tell us nothing, that will satisfy the curiosity of an inquisitive person.[16]

The best explanations of natural phenomena, according to Boyle, rely completely on mechanics. Everything within the physical world can be explained by reference to matter and motion alone. The various combinations of minute particles of matter produce all the phenomena within the physical world without need to resort to incorporeal entities or independently-existing forms or qualities. Therefore a particular colour of blue, for instance, is produced as the result of the particular shape and texture of corpuscles comprising the blue object rather than a form of 'blueness' within the object.[17] All phenomena are adequately explained with reference only to material entities and their motions. Instead of forms and qualities, the nature and function of

physical bodies

> likewise may be deduc'd fro(m) ye same Euident & obvious Principles; by wch if they could be explicated, they would noe longer be occult Qualitys."[18]

The only thing needed for explanation is

> matter and the accidents of matter being sufficient to explicate as much of the phenomena of nature as we either do or are like to understand.[19]

Not only could phenomena within the universe be explicated using a mechanistic frame of reference but all physical bodies and changes within them could be described by referring back to the basic material composition of these bodies. Any change is simply a result of changes to the structure of the particles which combine to make up the body. Qualitative differences in matter are due to the particular size, shape, motion and configuration of the corpuscles of which the matter is composed. Boyle thought that

> if the principles proposed be corporeal things, they will be then fairly reducible, or reconcilable, to the mechanical principles; these being so general and pregnant, that among things corporeal, there is nothing real...that may not be derived from, or be brought to, a subordination to such comprehensive principles.[20]

The corpuscularian philosophy is "easily comprehended" because "there cannot be fewer principles than the two grand ones of...matter and motion."[21]

Boyle certainly did not deny the existence of metaphysical or theological issues, such as the relationship

of God to the natural world, and he was not trying to avoid them by focussing only on natural phenomena that functioned in a blind, mechanical fashion. However, he believed that integrating theology within the mechanical framework, as More had attempted by injecting the void with a spirit, would ultimately lead to the deterioration of Christian theology because nature itself would then be deified. If matter, or its correlative void, were active, the tendency might be to ignore or reduce the transcendent power of God, something the pious Boyle could never concede.

By providing a mechanical explanation Boyle did not want

> to prove that no angel or other immaterial creature could interpose in these cases; for concerning such agents, all that I need say, is, that in the cases proposed we have no need to recur to them.[22]

Within the parameters of the mechanical philosophy, incorporeal agents were simply unnecessary. Metaphysical and theological issues, while not to be neglected, were best dealt with by other means. Therefore Boyle believed that physics and metaphysics should remain distinct and he proposed to present his theories

> of Natural Things as a Naturalist, without invading the Province of Divines, by intermedling with Supernatural Mysteries...[23]

Thus, he rejected explanations which relied on non-physical or non-material entities. This attitude explains his rejection of More's use of the void to bridge the gap

between physics and metaphysics. It also explains why he did not attempt, as Charleton had done, to prove the existence of void.

Boyle argued that entities which could not be sensed or measured could not be used as valid explanatory devices within the mechanical framework. Therefore since a vacuum could not be positively sensed, he refused to give it any explanatory power, just as he rejected the importance of Aristotelian forms or

> any such indeterminate agents, as the soul of the world, the universal spirit, the plastic power, and the like[24]

Although Boyle did acknowledge the existence of some types of incorporeals, such as angels and souls, he refused to give them explanatory power in natural philosophy. While souls are real incorporeals capable of acting on the matter of the human body, the mechanism behind them cannot be understood, therefore it is invalid to use such incorporeals as explanatory devices within the sphere of matter.

Thus, Boyle rejected any program, such as Charleton's, that extrapolated from incorporeals significant within the theological framework to incorporeals within the mechanical framework. He also used this reasoning to reject More's program which attempted to put a spirit of nature in the void. While Boyle never directly rejected More's spirit of nature, he believed it was simply not necessary to explain things within the natural world.

Boyle developed a corpuscularian interpretation of nature that did not incorporate the void. He discussed the merits of both Epicurean and Cartesian versions of mechanism stating that

> the Atomical and Cartesian hypotheses, though they differed in some material points from one another, yet in opposition to the Peripatetic and other vulgar doctrines they might be looked upon as one philosophy for they agree with one another, and differ from the schools in this grand and fundamental point, that not only they take care to explicate things intelligibly; but that whereas those other philosophers give only a general and superficial account of the phaenomena of nature from certain substantial forms;...both the Cartesians and the Atomists explicate the same phaenomena by little bodies variously figured and moved.[25]

Declaring that he did not "give myself up to any sect,"[26] he did not distinguish between the Cartesian and atomist versions of the mechanical philosophy because they both employed small corpuscles to explain natural phenomena. Therefore

> whether you admit the atomical hypothesis or prefer the Cartesian, I think it may be probably deduced from either, that very many of the bodies we are treating of may be supposed exhaleable as to their very minute parts.[27]

Boyle did however, acknowledge the differences between the two mechanical philosophies as centering on

> the notion of body in general, and consequently about the possibility of a true vacuum; as also about the origin of motion, the indefinite divisibleness of matter, and some other points of less importance than these[28]

Although a conflict did exist between these two versions, Boyle stated that "they may be considered as 'one philosophy'"[29] simply because they both explained things in terms of small particles of matter.[30]

Boyle's contemporaries sought to maintain a clearer distinction between these two philosophies and found support for their respective views in Boyle's vacuum experiments. An evaluation of what remained in the receiver after the piston had moved depended on which version of the mechanical philosophy one wished to support. It was commonly recognized that

> certainly both the Cartesians and Epicureans will find themselves highly concern'd in this matter. The former will endeavor thereby to establish the necessity of their Materia subtilis, to maintain the Plenitude of the World, and the Circle they attribute to Moving Bodies. The latter will think, they have cause here to triumph, as believing to have met with a more illustrious Instance, than ever, of their Vacuum Coacervatum within the World; since here is an impenetrable Vessel, out of which 'tis manifest, that an almost incredible proportion of Aerial substance hath been made to issue; whereas 'tis no ways manifest to any of our sense, that any other Body hath got in to succeed in its room.[31]

Boyle avoided taking a position in the controversy between these two versions of mechanism. He believed that

> I have neither the leisure, nor the ability, to enter into a solemn debate of so nice a question...nor dare I yet take upon me to determine so difficult a controversy.[32]

He would only acknowledge that there is "one catholic or universal matter common to all bodies, by which I mean a

substance extended, divisible, and impenetrable."[33] Both versions of the mechanical philosophy accepted this proposition. Since the ultimate differences between the two hypotheses "seem to be rather metaphysical than physiological notions,"[34] Boyle refused to enter into the debate and did not address the question of the void directly.

Boyle's refusal to address the metaphysical issues associated with an acceptance of the void indicates his attempt to establish a program of natural philosophy which kept physics and metaphysics quite separate.[35] He therefore rejected More's theory of a spirit of nature. However, Boyle feared the atheism that he thought might result from a mechanistic philosophy of nature. Therefore, he carefully argued that although physics and metaphysics did not have to overlap, they were, nevertheless, not mutually exclusive. Rather

> I do not think the corporeal world, nor the present state of things, the only or the principal subjects, that an inquisitive man's pen may be worthily employed about; and that there are some things, that are grounded neither upon mechanical nor upon chemical notices or experiments, that are yet far from deserving to be neglected, and much less to be despised, or so much as to be left uncultivated, especially by such writers, as being more concerned to act as Christians, than as virtuosi, must also think, that sometimes they may usefully busy themselves about the study of divine things, as well as at other times employ their thoughts about the inspection of natural ones.[36]

Although not explaining his physics through his metaphysical frame of reference, which was the mistake that Boyle thought More had made, Boyle nonetheless moulded his natural philosophy to conform to his theological and metaphysical assumptions. One admirer recognized this and told Boyle that he

> read your theology as the life of your philosophy, and your philosophy as animated and dignified by your theology, yea indeed as its first part.[37]

Boyle managed to insure that his physics, kept as a separate and distinct endeavor, did not subvert or jeopardize his theological assumptions by declaring that there are some areas that cannot be adequately explained without revelation, since "ye Fabrick of ye World is but <u>one</u> of ye <u>mediums</u> wch we employ to shew, that there is a God."[38] Therefore, the inadequacy of reason, when focussed on some areas, indicated to Boyle the <u>necessity</u> of revelation and faith for a fuller understanding of the world than natural philsophy alone could provide.[39] Consequently Boyle was able to ensure the importance of theology, an aim he shared with More. However, their approaches to this common goal differed, for, in contrast to More, Boyle maintained the pre-eminence of theology by <u>not</u> incorporating it within the framework of the mechanical philosophy.

Another way in which Boyle managed to ensure that a mechanist interpretation would not lead to atheism and materialism was to continue the attempts made by Gassendi

and Charleton to 'Christianize' Epicurean atomism.[40] Boyle's corpuscularian philosophy was a compilation of all those parts of Cartesianism and atomism which he thought could be reconciled to Christian theology. He presented it as the basis of a new program while still preserving traditional theological assumptions.

So that he would not be accused of atheism, Boyle assiduously marked out those areas of Epicurean atomism and Cartesianism to which he objected. In The Origin of Forms and Qualities he stated,

> though I agree with our Epicureans in thinking it probable that the world is made up of an innumerable multitude of singly insensible corpuscles endowed with their own sizes, shapes, and motions; and though I agree with the Cartesians in believing...that matter hath not its motion from itself, but originally from God; yet in this I differ both from Epicurus and Des Cartes, that whereas the former of them plainly denies that the world was made by any deity...and the latter of them,...thought that God, having once put matter into motion, and established the laws of that motion, needed not more particularly interpose for the production of things corporeal, nor even of plants or animals, which, according to him, are but engines: I do not at all believe that either these Cartesian laws of motion, or the Epicurean casual concourse of atoms, could bring mere matter into so orderly and well contrived a fabrick as this world...[41]

It is therefore clear that Boyle's disagreements with these two versions of mechanism focussed on theological rather than scientific concerns. Boyle wanted to reconcile theology and particulate matter theory, not through recourse to a void or spirit of nature, but through acknowledgement

of God's power to initially create and to continue to order the matter comprising the world.[42]

He was acutely aware that the mechanical philosophy could be interpreted to suggest that the world could be understood and explained without God. To avoid this conclusion, Boyle described his disagreement with some of the atomists' views since he did not "embrace all Epicurus's principles, but dissent from him in some main things."[43] Boyle expressed his chief concern with the atomists when he referred to them as "those great denyers of creation and providence."[44] Other difficulties arose from the Epicurean notion that atoms have an internal weight or gravity which carries them naturally downward. Epicurean atoms were also "selfe moving...(with) no Externall Agent from wch it needs, or can, derive its motion."[45] These Epicurean ideas were all theologically problematic because they did not acknowledge God as the initial creator or source of motion.

Boyle did not think these difficulties were insurmountable. More, aware of the same difficulties, had attempted to rid Epicureanism of these atheist tendencies by injecting divine power into inactive matter through the void. Charleton as well, sought to strengthen Christian assumptions of God's existence by proving the existence of the void, and thereby of incorporeals. Boyle's attempt to avoid these theological difficulties was quite different. Rather than pointing to a correlative for an incorporeal

soul or power in the physical world as a means to confirm the existence of a spiritual realm, Boyle applauded the fact that there was nothing in the physical world comparable to anything within the spiritual realm.

Boyle used the argument from design to establish God's role in nature. The study of nature and the explanation of natural phenomena in terms of material entities did not divert one's attention from the worship of God. Rather, the "experimental philosophy is, in its own nature, friendly to religion in general."[46] Therefore it followed that "there is no inconsistence between a man's being an industrious virtuoso, and a good Christian."[47] In fact, the natural philosopher was perhaps more able to see God's work exhibited in nature and would therefore be the least likely to profess atheism.

By studying nature one could not help but be convinced that there was a first cause and that God is omnipotent and benevolent. Boyle believed that

> the discoveries made by the help of physical or mechanical experiments are not, for the most part, of kin to religion; yet, besides that, some of them do manifestly conduce to establish or illustrate natural theology[48]

Studying natural philosophy could provide evidence to support metaphysics. In this way

> the consideration of God's providence, in the conduct of things corporeal, may prove, to a well-disposed contemplator, a bridge, whereon he may pass from natural to revealed religion.[49]

One must look for God's providence in natural philosophy as evidence for his existence.

Boyle objected to More's program which considered interstitial void to be the bridge through which God's providence acted on the material world. Boyle's criticism of More focused on his methodology, which gave incorporeals explanatory power. He also thought that More's spirit of nature, as an intermediate agent between the natural world and God, would not allow enough scope for the operation of divine will. Such a stance conflicted with Boyle's voluntarism.

More had argued for the necessity of interparticulate vacuum in order to explain such natural phenomena as rarefaction and condensation. The necessity of void in the operation of the natural world also supported his proof of other incorporeal entites such as angels and an immortal soul. Boyle did not object to this attempt to prove the existence of spiritual entities, but he did object to More's method of arriving at these conclusions. Boyle accused More of trying to prove the existence of immaterial entities by appealing to physical experiments. More acknowledged, in reference to "Boiles Hydrostaticks" that he was "not altogether satisfyde that his [Boyle's] paradoxicall Inferences from the experiments are true," but rather sought to interpret them as showing that "there will be a Spiritt of Nature for all this."[50] He was determined to incorporate

such an active spirit into the operations of the universe.[51]

However, Boyle was convinced that spirit could not be defined in terms similar to those used to define matter.[52] Likewise, the operations of matter could not be defined in terms which relied involved spirit. Boyle stated that he wanted to explain things

> without recourse to a fuga vacui, or the anima mundi, or any such unphysical principle.[53]

This however, did not mean that

> no angel or other immaterial creature could interpose in these cases; for concerning such agents, all that I need say, is, that in the cases proposed we have no need to recur to them.[54]

Spiritual agents are not required to build adequate explanations.[55] Boyle did not want to argue that

> there can be no such thing as the learned doctor's principium hylarchicum but only to intimate, that, whether there be or not, our hydrostaticks do not need it. Nor do I think it necessary to the doctor's grand and laudable design, wherein I heartily wish him much success of proving the existence of an incorporeal substance.[56]

Boyle's insistence on using only mechanical operations of material entities prevented him from accepting an immaterial entity as a plausible explanation for any material function. He therefore rejected Charleton's use of the analogy between soul and body, on the one hand, and vacuum and matter, on the other. Although Boyle did recognize the existence of an immortal soul he opposed any attempt to demonstrate its existence by appealing to experimental philosophy. For

> the union of the body and soul; which being settled at first by God's arbitrary institution,

> and having nothing in all nature parallel to them, the manner and terms of that strange union is a riddle to philosophers, but must needs be clearly known to him, that alone did institute it.[57]

Boyle accepted the immortality of an immaterial soul not because of any similarity or analogy he was able to find between it and things in the material world, such as a vacuum, but precisely because there is nothing 'in all of nature' that compares to it. Since the rational soul has certain functions such as understanding, conceiving of abstractions and universals, and free will, and since these functions are

> peculiar to the human mind, and superior to anything, that belongs to the outward senses, or to the imagination itself, manifest, that the rational soul is a being of an higher order than corporeal; and consequently, that the seat of these spiritual faculties, and the source of these operations, is a substance, that being in its own nature distinct from the body is not naturally subject to die or perish with it.[58]

Since the mind is capable of doing things of which matter is not capable, it is a distinct kind of substance. Boyle's argument for the existence of an immortal soul, in contrast to Charleton's, was thus based not on the similarities between the soul and other things operating in nature but rather on its differences from things operating in nature.

Boyle did not infer, however, that incorporeals should be entirely disregarded when looking at the material world. Since

> it is not reasonable to expect, that we, who have but an inadequate knowledge of the least of corporeal things, should have an adequate one of

> incorporeal ones; or to pretend, that we ought not to cultivate the knowledge of divine things, and immaterial substances, because we cannot perfectly understand them; whilst we are diligent and hopeful cultivators of the science of bodies, which we are very far from perfectly comprehending.[59]

Therefore, it is not the study of incorporeals themselves that Boyle disputed in Charleton's program, but rather the way in which he had transplanted statements about entities in the theological realm into the mechanical realm. Boyle was sure the operations of the human soul could not be explained by mechanical principles alone. For

> some faculties and operations of the reasonable soul in man are of so peculiar and transcendent a kind, that as I have not yet found them solidly explicated by corporeal principles, so I expect not to see them in hast made out by such.[60]

There is a limit to the explanatory power of corpuscularianism. Boyle expressed

> great doubt, whether there be not some phaenomena in nature, which the atomists cannot satisfactorily explain by any figuration, motion, or connection of material particles whatsoever.[61]

The realm explained by physical principles does not coincide with the realm explained by metaphysics and theology. Unlike More, Boyle believed the distinction between the two could be fully acknowledged without a loss of explanatory power in either. In fact, Boyle thought that any attempt to merge the two would ultimately lead to a loss of explanatory power in the theological realm by limiting God's omnipotence. Linking the two would only demean the

significance of the soul, and therefore, of God.

In addition to his objections to More's use of the void as a means to bridge the gap between the material and immaterial worlds, Boyle viewed More's use of the void, and the associated implications that he made with it, as theologically dangerous, on methodological grounds. Boyle had rejected the Aristotelian program because of its claim that nature exhibits activity such as the avoidance of vacuum. Boyle believed that a self-active natural world would diminish God's power over matter and, therefore, he also objected to More's claim that nature is imbued, through interstitial spaces, with active forces. Boyle believed that

> the excessive veneration men have for nature, as it has made some philosophers (as the Epicureans) deny God, so it is to be feared, that it makes many forget him: and, perhaps, a suspicious person would venture to add, that, if other principles hindered not (as, I know, that in many, and, I think, that in most of the Christian naturists they do) the erroneous idea of nature would, too often, be found to have a strong tendency to shake, if not to subvert, the very foundations of all religion; misleading those, that are inclined to be its enemies, from over-looking the necessity of a God, to the questioning, if not to the denial of his existence.[62]

For Boyle, mechanical explanations in terms of inactive matter were just as successful and did not threaten the dominion of God.

More introduced, through his spirit of nature, an intermediate agent which reduced the operation of divine

power. Boyle's rejection of More's approach is directly related to his voluntarist theology which also explains his rejection of Aristotlean qualities and Platonic forms. There can be no entity mediating between God and the created world because such an entity would restrict God's omnipotence.[63] Boyle believed that there is "a direct and particular intervention of the divine power"[64] rather than any sort of indirect action through the vacuum. While More thought he could make God's power more evident by giving it a pathway, understandable in the framework of the mechanical philosophy, Boyle considered such a maneuver denigrating to divine power, which did not require any sort of mechanical explanation.

Furthermore, such an explanation made the cause of motion and change an agent other than a transcendant God. Boyle did not regard such an explanation plausible

> for if indeed there were such an intelligent, powerful, and vigilant being, as philosophers are wont to describe nature to be, divers things would not be done, which experience assures us are done.[65]

Explanations dependent on the direct presence of God would not be needed if too much power were given to nature itself.

Therefore, Boyle rejected More's use of void as the receptacle for an intermediary spirit in nature just as he had rejected the Aristotelian notion that nature abhors a vacuum. The Aristotelians had thought that water moved upward in a tube in order to fill the empty space, an

explanation which Boyle did not accept.

> whereas the Aristotelians make as if they would Teach men something, when they make a great noise with their Simpathyes and Antipathy's' tis plaine that they doe not thereby at all Explicate occult qualities but only Disguise them by new names.[66]

To assume this is why the water rises

> supposes that there is a kind of anima mundi, furnished with various passions, which watchfully provides for the safety of the universe; or that a brute and inanimate creature, as water, not only has a power to move its heavy body upwards, contrary (to speak in their language) to the tendency of its particular nature, but knows both that air has been sucked out of the reed, and that unless it succeed the attracted air, there will follow a vacuum; and that this water is withal so generous, as by ascending, to act contrary to its particular inclination for the general good of the universe, like a noble patriot, that sacrifices his private interests to the publick ones of his country.[67]

Instead, Boyle argued that water moves upward in a tube as the result of the mechanical action of the atmospheric pressure.[68] He was arguing here against those explanations of both Aristotle and More which gave sense and activity to nature. Instead of explaining the rising of a liquid in a tube in terms of the activity within the matter or in terms of the power within the void to act upon the matter, Boyle put forth a mechanical explanation and argued

> the quite contrary from the phaenomena, that occur about a vacuum. For whereas it is alledged, that nature, in great pumps, and in the like cases, lifts up the heavy body of water in spite of its tendency towards the centre of the earth, to obviate, or fill up a vacuity; and that out of a gardener's pot, or inverted pipe, stopped at one end, neither the water, nor even quicksilver, that is near fourteen times as heavy, will fall down, least it should leave a vacuum behind it; I

> demand, how it comes to pass, that, if a glass pipe be but a foot longer than 34 or 35 feet or an inverted tube, filled with quicksilver, be but a finger's breadth longer than 30 inches, the water in the one, and the quicksilver in the other, will subside, though the one will leave but about a foot, and the other but about an inch, of deserted space, which they call vacuum, at the top of the glass?[69]

Given the nature of Boyle's conceptual framework, which was moulded by his theological assumptions, he could not see how it could be

> intelligibly made out, how hatred or aversation, which is a passion of the soul, can either for a vacuum, or any other object, be supposed to be in water, or such like inanimate body, which cannot be presumed to know, when a vacuum would ensue, if they did not bestir themselves to prevent it; nor to be so generous as to act contrary to what is most conducive to their own particular preservation for the public good of the universe.[70]

Giving such activity to matter or vacuum restricted God's power over nature. Boyle's requirement that matter be inert and without self-action allowed him to acknowledge God's power and presence.[71] Rather than relying on explanations that put activity into matter, either directly or through the vacuum, Boyle maintained that

> (since nature's hatred of a vacuum is but metaphorical and accidental, being but a consequence or result of the pressure of the air and of the gravity, and partly also of the fluxility of some other bodies) the power she makes use of to hinder a vacuum, is not...any such boundless thing, as men have pleased to imagine.[72]

Therefore, it is evident that Boyle objected to More's use of vacuum as an explanatory device for both methodological and theological reasons. Instead of seeking

to encompass all natural and theological phenomena within the parameters of the mechanical philosophy, as More had attempted, Boyle could accept that there were some things that simply could not be explained.

> ...it is not always necessary to the making the belief of a thing rational, that we have such a comprehension of the thing believed as may be had, and justly required in ordinary cases...[73]

Since matter and motion suffice to explain all natural phenomena it is better to rely on these factors alone as explanatory devices within the mechanical framework since

> if recourse be had to an immaterial principle or agent, it may be such an one, as is not intelligible; and however it will not enable us to explain the phenomena, because its way of working upon things material, would probably be more difficult to be physically made out, than a mechanical account of the phenomena. And notwithstanding the immateriality of a created agent, we cannot conceive, how it should produce changes in a body, without the help of mechanical principles, especially local motion; and accordingly we find not, that the reasonable soul in man is able to produce what changes it pleases in the body, but is confined to such, as it may produce by determining, or guiding the motions of the spirits, and other parts of the body, subservient to voluntary motion.[74]

Advocating mechanical explanations, Boyle promoted corpuscularianism and experimentalism because he believed that, "the Informations of Sense assisted and hightned by instruments are usually preferrable to those of Sense alone."[75]

Boyle, therefore, promoted an explanation of natural phenomena which relied only on the motions and

configurations of particles of inactive matter, criticizing those who attempted explanations which appealed to incorporeals. Nonetheless, Boyle's reliance on the observation of material entities to achieve knowledge was founded on unobservable atoms and negative sense perceptions. Since Boyle's corpuscularianism assumed the existence of minute particles which could not be directly observed or sensed, he had to develop a program that would give explanatory power to these unobservables. He also had to justify his use of vacuum to explain such phenomena as rarefaction and condensation but which he rejected when used by More to promote the idea of activity in nature. Although Boyle employed the void as an heuristic device to argue against Aristotelian, and Cartesian, plenist arguments that could give no adequate explanation of rarefaction and condensation, he knew that the void raised contentious theological and metaphysical issues. Boyle, therefore, did not want to <u>prove</u> the existence of void, as Charleton was eager to do, or equate it with a spiritual form of incorporeal, such as the soul. He chose, rather, to use it as an explanatory device without committing himself to its real existence.[76]

Therefore, void functioned in the same way as cold which was characterized by Boyle as the deprivation of heat. Even though cold and void could not be positively sensed they could nonetheless produce positive sense perceptions.

They could, therefore, provide legitimate knowledge of the world. He suggested that

> to our confused, and often also to our inadequate conceptions, belong many of those, that may be called negative, which we are wont to employ, when we speak of privations or negations, as blindness, ignorance, death, etc. We have a positive idea of things, that are square and round, and black and white, and in short of other things, whose shapes and colours make them the objects of our sight; but when we say, for instance, that a spirit or an atom is invisible, those words are attended with a negative conception, which is commonly but dark and confused, because it is indefinite, and removes or lays aside those marks, by which we are wont clearly to perceive and distinguish visible substances.[77]

Giving significance to negative sense perceptions allowed Boyle to justify the importance of indefinite or incorporeal entites such as vacuum without giving such incorporeals a direct explanatory power. Therefore, Boyle explained such occurrences as rarefaction in terms of the increased distance between the material corpuscles rather than in terms of the incorporeal vacuum. In order to avoid declaring himself either for or against the existence of a void, Boyle simply stated that there was an absence of air in his receivers. This was

> the Vacuum Boylianum, which he therefore thinks the less improper, because to call it Vacuum absolutely, would be judged by many a declaring himself a Vacuist, who does not yet own the being either of their opinion, or a downright Plenist; or else he must be troublesome to the Reader and himself, by frequently explaining, what sort of Vacuum he understands; whereas he declares once for all, that by the Vacuum Boylianum he means such a Vacuity or Absence of Common Air, as is wont to be effected or produc'd in the operations of the Machina Boytliana.[78]

Boyle avoided direct assertion of the reality of vacuum although it was a useful explanatory component of his natural philosophy. His reluctance to decide on the issue of the actual existence of void did not arise simply because the void could not be sensed. Boyle considered minute particles, or minima, which also could not be directly sensed, to be real, existing entities. He speculated that one day, with the advent of more powerful microscopes, even atoms would be sensed. It was not improbable therefore, that

> by these helps the subilty of the composition of Bodies, the structure of their parts, the various texture of their matter, the instruments and manner of their inward motions, and all the other appearances of things, may be more fully discovered[79]

On the other hand, void, being entirely immaterial, would never be directly sensed, even with the development of more sophisticated instruments. Void was unobservable, in principle, not because it was small, like atoms, but because it was incorporeal. There could never be direct empirical evidence for its existence.

In his corpuscularian program, Boyle avoided asserting the existence of an immaterial entity such as the void but relied heavily on explanations using insensible atoms. Therefore, he made statements about visible, 'positive' perceptions and entities based on assumptions about other, invisible, but also 'positive' entities or that

> of some things we have a knowledge, that, for want of a fitter term, may be called primary or direct; and of some other things the knowledge we have is acquired but by inferring it from some more known or clearer truth, and so may be called inferred or illative knowledge.[80]

The operations of nature occur on a visible as well as an invisible level. Therefore

> to say, that though in natural bodies, whose bulk is manifest and their structure visible, the mechanical principles may be usefully admitted, that are not to be extended to such portions of matter, whose parts and texture are invisible; may perhaps look to some, as if a man should allow, that the laws of mechanism may take place in a town clock, but cannot in a pocket-watch;[81]

This kind of extrapolation meant that knowledge was not confined to the often weak and fallible human senses but could be extended through the use of reason and experimental methods utilizing instruments. As a 'manipulative' realist, Boyle believed unobservable atoms were actually-existing since observable results fit the belief that they were.[82] Boyle's use of such a method elucidates the assumptions about the nature of the world on which he built his natural philosophy.

## Notes - Chapter Three

1. For background information on Boyle see Marie B. Hall, "Robert Boyle," Dictionary of Scientific Biography, Vol. II, ed. Charles C. Gillispie, (New York: Charles Scribner's Sons, 1974), 377-382; and Desmond Reilly, "Robert Boyle and his Background," Journal of Chemical Education 28 (1951): 178-183; and Meyrick H. Carré, "Robert Boyle and English Thought," History Today 7 (1957): 322-327.

2. For a description of his experiments with air see James B. Conant, "Robert Boyle's Experiments in Pneumatics," in Harvard Case Studies in Experimental Science, Vol. 1, (Cambridge: Harvard University Press, 1957), 1-63; R.T. Gunther, Early Science in Oxford, Vol. 1, (Oxford: Oxford University Press, 1923); Marie B. Hall, "Robert Boyle," Scientific American 217 (1967): 96-102.

3. Robert Boyle, Of the Usefulness of Natural Philosophy in Robert Boyle. The Works 6 Vol. ed. Thomas Birch intro. Douglas McKie (London: 1772; repr., Hildesheim: Georg Olms Verlasgsbuchhandlung, 1965), 39. Subsequent references to Boyle's writings in this six volume set will indicate the volume and page number. For a discussion of the use of analogy in order to understand unobservable entities, in the work of both Boyle and Newton, see William J. Green, "Models and Metaphysics in the Chemical Theories of Boyle and Newton," Journal of Chemical Education 55 (1978): 434-436; for a further discussion of the hypothetical nature of the mechanical philosophy and the use of analogy see Laurens Laudan, "The Clock Metaphor and Probabilism: The Impact of Descartes on English Methodological Thought, 1650-65," Annals of Science 22 (1966): 73-104.

4. J.J. MacIntosh, "Perception and Imagination in Descartes, Boyle and Hooke," Canadian Journal of Philosophy 13 (1983): 327-352. This article suggests that Boyle's reluctance to choose between atomism and Cartesian was motivated by his "continually open mind" that accepted any version within a corpuscularian framework (341).

5. For a discussion of the fear of atheism in relationship to the new mechanical philosophy see Richard S. Westfall, Science and Religion in Seventeenth-Century England (New Jersey: Yale University Press, 1958; repr., Ann Arbor: University of Michigan Press, 1973), 108-145; also J.J. MacIntosh, "Robert Boyle on Epicurean Atheism and Atomism," in Atoms, Pneuma, and Tranquility: Epicurean and Stoic Theories in European Thought, ed. Margaret J. Osler, (Cambridge: Cambridge University Press, forthcoming); see also E.J. Dijksterhuis, The Mechanization of

the World Picture. Pythagoras to Newton, 441; John J. Renaldo, "Bacon's Empiricism, Boyle's Science, and the Jesuit Response in Italy," Journal of the History of Ideas 37 (1976): 689-695 suggests that Jesuit orders disagreed with atomism not so much because of its implied atheism or immorality but more because of the "epistemic implications of empirical atomism," since they put more emphasis on traditionally accepted forms of knowledge acquisition such as revelation and the spoken word. (690).

6. The view that metaphysical assumptions moulded Boyle's science is presented in J.H. Kultgen, "Boyle's Metaphysic of Science," Philosophy of Science 23 (1956): 136-141.

7. Margaret J. Osler, "The Intellectual Origins of Robert Boyle's Philosophy of Nature: Gassendi's Voluntarism and Boyle's Physico-Theological Project," in Philosophy, Science, and Religion, 1640-1700 ed. Richard Kroll, Richard Ashcroft and Perez Zagorin (Cambridge: Cambridge University Press, forthcoming).

8. Margaret J. Osler, "Baptizing Epicurean Atomism: Pierre Gassendi on the Immortality of the Soul," in Religion, Science, and Worldview, ed. Margaret J. Osler and Paul L. Farber, (Cambridge: Cambridge University Press, 1985), 164.

9. Robert Boyle, The Sceptical Chemist, 1.459.

10. Ibid, 461.

11. Ibid. 464.

12. Ibid, 468.

13. Robert Boyle, Some Considerations touching the Usefulness of Experimental Natural Philosophy, 2.36.

14. Robert Boyle, The Christian Virtuoso, 5.516.

15. Ibid.

16. Robert Boyle, On the Excellency of the Mechanical Philosophy, 4.72.

17. Boyle outlined the basics of his corpuscularian program in The Origin of Forms and Qualities, According to the Corpuscular Philosophy, 3.1-112. An outline of his program can also be found in Herbert Butterfield, The Origins of Modern Science, 1300-1800 (Thetford, Norfolk: Lowe & Brydone, 1957; repr., Toronto: Clarke, Irwin & Co. Ltd., 1977), Ch. VII, as well as in E.J. Dijksterhuis, The Mechanization of the World Picture. Pythagoras to Newton, trans. C. Dikshoorn, (Princeton: Princeton University Press, 1950), 431-444. Using Boyle's characterization of matter and motion as the fundamental components comprising all things,

qualities, then, are, "not non-relational inherent properties of things, but rather are non-inherent relational properties of things." Frederick J. O'Toole, "Qualities and Powers in the Corpuscular Philosophy of Robert Boyle," Journal of the History of Philosophy 12 (1974): 295-315, (see 307).

18. Robert Boyle manuscript, Boyle Papers Vol. 2 (Archives of the Royal Society of London) Notes upon Occult Qualities. I am very grateful to Professor J.J. MacIntosh for providing me with a transcript of this manuscript.

19. Robert Boyle, The Origin of Forms and Qualities, 3.38. Joseph Glanvill also thought natural phenomena could best be described from within the mechanical framework;

> By demonstrative Philosophy
> They playnly prove all things are bodyes,
> And those that talke of Qualitie
> They count them all to be meer Noddyes.
> Nature in all her works they trace
> And make her as playne as nose in face.

as quoted in Dorothy Stimson, "Ballad of Gresham College," Isis 18 (1932): 108-117.

20. Robert Boyle, About the Excellency and Grounds of the Mechanical Philosophy, 4.76.

21. Ibid, 70.

22. Robert Boyle, An Hydrostatical Discourse, 3.609.

23. Robert Boyle, The Origin of Forms and Qualities according to the Corpuscular Philosophy, 3.7.

24. Robert Boyle, About the Excellency and Grounds of the Mechanical Philosophy, 4.72.

25. Robert Boyle, Some Specimens of an Attempt to make Chymical Experiments Useful to illustrate the Notions of the Corpuscular Philosophy, 1.355.

26. R. Boyle, The Christian Virtuoso, 5.512.

27. R. Boyle, Notes about the Atmosphers of Consistent Bodies..., 3.278.

28. R. Boyle, Some Specimens of an Attempt to make Chymical Experiments usefull..., 1.355.

29. R. Boyle, Spring and Weight of the Air, 1.35.

30. Although Boyle did not distinguish between the two interpretations, he was not so flexible to concede the basic matter to be other than corpuscularian, therefore it is not just an hypothesis but rather a statement about how he views the world. See Thomas Kuhn, "Robert Boyle and Structural Chemistry in the Seventeenth Century," Isis 43 (1952): 12-36, 19.

31. Anonymous, "An Account of some Books," Philosophical Transactions of the Royal Society Vol. 5, No. 67. 1671/72, 2053.

32. R. Boyle, Spring and Weight of the Air, 1.

33. R. Boyle, Forms and Qualities 3.15.

34. R. Boyle, Some Specimens of an Attempt to make Chymical Experiments..., 1.355.

35. Richard M. Hunt, The Place of Religion in the Science of Robert Boyle (Pittsburgh: University of Pittsburgh Press, 1955) argues that Boyle avoided the "theoretical implications" of the new science by "keeping theology superior to science." (59).

36. Robert Boyle, The Christian Virtuoso, 5.510.

37. Mr. R. Baxter to Robert Boyle (June 14, 1665), 6.516.

38. R. Boyle manuscript, Boyle Papers Vol. 2, 31.

39. Richard S. Westfall, "Unpublished Boyle Papers Relating to Scientific Method," Annals of Science 12 (1956): 103-117, 109.

40. See Margaret J. Osler, "Baptizing Epicurean Atomism: Pierre Gassendi on the Immortality of the Soul," in Religion, Science, and Worldview, ed. Margaret J. Osler and Paul L. Farber, (Cambridge: Cambridge University Press, 1985) for a discussion of the modifications Gassendi made to Epicurean atomism in order to reconcile it to Christian theology.

41. Robert Boyle, The Origin of Forms and Qualities, 3.48.

42. Frederick J. O'Toole, "Qualities and Powers in the Corpuscular Philosophy of Robert Boyle," Journal of the History of Philosophy 12 (1974): 295-315 says that Boyle's concept of God's role as "creator and governor of the physical universe" was the main difference between his natural philosophy and both ancient and contemporary atomists (296).

43. Robert Boyle, The Sceptical Chemist, 1.571.

44. R. Boyle manuscript, Boyle Papers Vol. 2, 5.

45. Ibid.

46. Robert Boyle, The Christian Virtuoso, 5.524.

47. Ibid, 508.

48. Ibid, 522.

49. Ibid.

50. Henry More to Lady Conway (March 17, 1666), in Marjorie H. Nicolson, Conway Letters. The Correspondence of Anne, Viscountess Conway, Henry More, and their Friends, 1642-1684 (New Haven: Yale University Press, 1930), 269.

51. He interpreted Boyle's experiments to fit with his own theological requirements. Samuel I. Mintz, The Hunting of Leviathan. Seventeenth-Century Reactions to the Materialism and Moral Philosophy of Thomas Hobbes (Cambridge: Cambridge University Press, 1969), 87-88.

52. Robert A. Greene, "Henry More and Robert Boyle on the Spirit of Nature," Journal of the History of Ideas 23 (1962): 474.

53. Robert Boyle, An Hydrostatical Discourse, occasioned by the Objections of the Learned Dr. Henry More, against some Explications of New Experiments made by Mr. Boyle, 3.596.

54. Ibid, 609.

55. Shapin and Schaffer, 217.

56. Ibid, 627-628.

57. Robert Boyle, Of the High Veneration Man's Intellect Owes to God, Peculiarly for His Wisdom and Power, 5.150.

58. Robert Boyle, The Christian Virtuoso, 5.517.

59. Ibid, 752.

60. Robert Boyle, Of the Usefulness of Natural Philosophy, 2.47.

61. Ibid.

62. Robert Boyle, A Free Inquiry into the Vulgarly Received Notion of Nature, 5.192.

63. Margaret J. Osler, "The Intellectual Origins of Robert Boyle's Philosophy of Nature...", 16-18.

64. Robert Boyle, The Christian Virtuoso, 5.520.

65. Robert Boyle, A Free Inquiry into the Vulgarly Received..., 5.192.

66. R. Boyle manuscript, Boyle Papers Vol 2, 2.

67. Robert Boyle, Of the Usefulness..., 38.

68. For a presentation of the development of concepts dealing with capillary action and cohesion see, E.C. Millington, "Theories of Cohesion in the Seventeenth Century," Annals of Science 5 (1941-1947): 253-269.

69. Robert Boyle, A Free Inquiry into the Vulgarly Received..., 5.192.

70. Robert Boyle, The Spring and Weight of the Air, 1.75.

71. Richard S. Westfall, "Unpublished Boyle Papers...", 109.

72. Robert Boyle, The Spring and Weight of the Air, 76.

73. Robert Boyle, Some Considerations about the Reconcileableness of Reason and Religion, 4.173.

74. Robert Boyle, Of the Excellency and Grounds..., 4.78.

75. Robert Boyle, "Propositions of Sense, Reason, and Authority," as quoted in R.S. Westfall, Unpublished Boyle Papers..., 115.

76. In A Defense of the Doctrine touching the Spring and Weight of the Air... (1.180), Boyle declared that explanations relying on the Epicurean notion of atoms and void were successful because,

> all the phaenomena of rarefaction and condensation, of light, sound, heat, etc. will naturally and necessarily follow.

77. Robert Boyle, A Discourse of Things above Reason, 4.421.

78. Anonymous, Philosophical Transactions of the Royal Society, Vol. 5, No. 63, 1670, 2035.

79. Anonymous, Philosophical Transactions of the Royal Society, Vol. 1, No. 2, 1665, 27.

80. Robert Boyle, Things above Reason, 4.421.

81. Robert Boyle, Of the Excellency and Grounds of the Mechanical Philosophy, 4.71.

82. Mandelbaum identifies this process as "inductive inference", 62.

## Conclusions

The seventeenth century challenge to traditional Aristotelianism involved shifts in fundamental concepts of the structure of matter and the causes producing physical changes. Without these changes the mechanical philosophy would never have threatened well-established views of the universe and how it worked. The development of an alternative theory of matter challenged accepted theories within mechanics, such as the explanation of motion without the Aristotelian theory of 'natural place'. The development of alternative theories also required that theological, epistemological and metaphysical issues be addressed.
In this thesis I chose to examine the conflicts and attempts at reconciliation that surrounded a notion of void in the mechanical philosophy. I focused on Charleton, More, and Boyle and their respective attitudes to the void, in order to discuss the relationship between the development of an alternative theory of matter and concerns linked to fundamental conceptual issues.

These supporters of the mechanical philosophy believed that it provided better explanations of natural phenomenan than either traditional Aristotelianism or animistic alternatives. However, the success of mechanical, and particularly atomist, explanations of such phenomena as rarefaction and condensation was counter-balanced by certain

difficulties. Accepting the existence of distinct, indivisible atomic particles implied, as a necessary corollary, the existence of void. In the mid-seventeenth century, the void was difficult to reconcile not only to the basic principles of the mechanical philosophy but also to Christian theology.

The various approaches taken by these supporters of atomism to the difficulties associated with the void shed light on several issues in the history and philosophy of science. Most significantly, they illustrate the importance of conceptual frameworks in the development of science. A conceptual framework is a body of assumptions about what the world consists of and how it operates. It is influenced by non-scientific assumptions, such as theological, epistemological and metaphysical beliefs. These beliefs influence the formation of a system of knowledge that must also provide adequate explanations of the physical structure and operation of the world.

Since a system of knowledge is a network of mutually-confirming beliefs, it would be inaccurate to suppose that science, as part of this network, developed in isolation, unaffected by issues in other areas, such as theology or metaphysics. For example, the barometric experiments of Torricelli and Pascal in the early 1600's did not refute once and for all the Aristotelian claim that nature abhors a vacuum. The empirical evidence alone was not enough to

convince people to accept the existence of void. Theological and metaphysical concerns also had to be considered before the void could ever be accepted. This need for the reconciliation of all branches of thought within a conceptual framework is clearly illustrated by Robert Boyle's reluctance to accept the existence of the void even though he employed it as a heuristic device in explanations of rarefaction and condensation. As already shown, his reluctance to prove the existence of void was not just motivated by his desire to put forth matters of fact from only within a material and mechanical frame of reference. He was also troubled by the heterodox implications of giving a non-corporeal entity explanatory power.

On the other hand, Henry More chose to support the idea that void was real, precisely because he wanted to give non-corporeals explanatory power and thought that doing so would remove atheist implications from atomism by lending credence to the existence of spiritual incorporeals such as the soul and God. Clearly, his support of atomism was rooted in his theological and metaphysical concerns.

A second issue within the history and philosophy of science, illustrated by the difficulties associated with the void, is the epistemological status of scientific theory during the seventeenth century. At that time, when the mechanical philosophy of nature challenged traditional

Aristotelianism, natural philosophers struggled to establish the boundaries of what could or could not be accepted as an explanatory device. Founding their philosophy of nature on the assumption of unobservable particles surrounded by immaterial void required them to develop a form of reasoning from observables to unobservables. This form of reasoning, which had to apply not only to material atoms but also to the immaterial void, led to several epistemological difficulties.

All three figures found it relatively easy to make assumptions about unobservable, material entities based on conclusions drawn from the observation of material entities. Making such assumptions required belief in the validity of sense experience and in the similarity of causation in both observable and unobservable realms. The development of technological aids which enhanced human senses, such as the microscope, made it more plausible to assume that structures and functions not easily observable were simply smaller versions of what could be readily observed. Acceptance of the existence of atoms was given further strength since the interpretation of results from experiments matched the belief that unobservable, material entities did indeed exist. Therefore, the use of extrapolation and analogy to support inferential knowledge was considered acceptable.

However, all three figures experienced more difficulty in their attempts to make assumptions about an unobservable,

immaterial entity such as the void. While the void was useful for explaining certain natural phenomena, such as rarefaction and condensation, it carried with it tremendous theological and metaphysical problems. The question of the possible existence of the void raised questions about whether God could be active in spaces devoid of all matter. Epistemological concerns were also raised by those who questioned whether knowledge could be acquired about a non-corporeal entity. Boyle, in particular, who promoted an explanation of natural phenomena which relied only on the motions and configurations of particles of inactive matter, criticized those who attempted explanations appealing to any type of incorporeal, even though he referred to vacuum as a useful, but nonetheless hypothetical, device in his own mechanical explanations. His objections to the use of vacuum in mechanical explanations were rooted in his desire for explanations founded on only material entities. Such explanations conformed not only to his theoretical framework within physics but also to his theological concerns that sought to prevent any injection of spirit into matter.

The persistent concerns surrounding the existence of void in the seventeenth century mechanical philosophy illustrate how difficult it was to reconcile the conflicts between various branches of thought. Boyle's apparent reluctance to accept or deny the reality of void resulted from his fear of the dangers of atheism associated with

atomism and hence the void. For him, the reconciliation between atomism and theology had not been established.

It is not clear that a reconciliation ever took place, for it is in the seventeenth century that one begins to see the gradual branching-off of various strains of thought, rather than a coalescing of areas. While the mechanical philosophy of nature was ultimately successful in explaining most natural phenomena, it left persistent philosophical problems. In particular, the void, while proven useful in explaining rarefaction, condensation and motion, left unshakeable problems in the philosophical theory of mind and soul. Theology demanded the existence of a human soul but its existence remained difficult to reconcile with a mechanical philosophy of nature. Biological experimentation in the eighteenth century raised even more difficult questions. In attempting to solve the problem of how the soul operated within a body that operated much like a machine, Descartes placed the connection in the pineal gland. However, later experiments disputed this simplistic solution. Observations of regeneration, first described in 1712 by Réaumur, were studied further by Trembley in 1741. He observed that when the freshwater polyp, Hydra, was cut into pieces, each piece regenerated into an entirely whole and separate individual. This demonstration seriously challenged the identification of an exact location for a generative entity. Regeneration also pointed to the

existence of a dispersed soul as well as the possibility of new creation.[1] It became increasingly difficult to relate a mechanical process among material particles to the experiential world of perception and feeling.

The success of the mechanical philosophy of nature was not absolute. Just as it engendered persistent philosophical problems about the nature of the soul, it also faced difficulties in scientific areas. The desire to pursue a strictly mechanistic approach to explain processes in biology resulted in shallow and often inaccurate perceptions. No lines were drawn between living and non-living things, with little difference existing between one's pet dog and an intricate mechanical clock. Analogies were drawn between physiological functions such as muscular movement and inanimate machines. A mechanical explanation of generation also developed but fell short of adequately explicating embryological development. Certainly part of its failure resulted from more sophisticated observations that required more sophisticated explanations.

It is clear that developments within physical science did not occur in isolation but were influenced by issues and concerns from other branches of thought. Many historians of science have highlighted the influence of social and political factors on the development of the mechanical philosophy in the seventeenth century. James R. Jacob and Margaret C. Jacob, in particular, have made strong claims

that "ideological and social factors proved crucial in the development of science in seventeenth-century England."[2] A recent book, by Steven Shapin and Simon Schaffer, examines the development of the experimental philosophy by "situating scientific method, and controversies about it, in a social context."[3] Using this approach, the authors suggest that experimental "matters of fact" were generated into consensus by using technical, literary and social tools with the ultimate goal being to keep the new science consistent with the overall social and political matrix. Boyle is cast as a deliberate conniver who presented his experimental results with feigned humility so as to enhance their acceptability.[4]

There certainly can be no question that social, political and ideological factors did, and still do, exert influence on the development of theoretical issues in science. However, the importance of theology, metaphysics and epistemology should not be overlooked. Emphasizing only social and political ideology or experimentalism to illustrate the development of science in the seventeenth century is, I think, too one-sided. Therefore, I consider seventeenth century conceptual shifts that led philosophers to view the world as a machine rather than an organism, to be just as significant as shifts in political ideology.[5]

## Notes - Conclusions

1. A. Vartanian, "Trembley's Polyp, La Mettrie and Eighteenth-Century French Materialism," Journal of the History of Ideas 11 (1950): 264.

2. James R. Jacob and Margaret C. Jacob, "The Anglican Origins of Modern Science: The Metaphysical Foundations of the Whig Constitution," Isis 71 (1980): 251-267; see also J.R. Jacob, "Restoration, Reformation and the Origins of the Royal Society," History of Science 13 (1975): 155-176, which suggests that science was promoted because it was considered "useful to capitalist enterprise." (163); see also J.R. Jacob, "Restoration Ideologies and the Royal Society," History of Science 18 (1980): 25-38, which also attempts to link developments within natural philosophy to political ideology in late seventeenth century England. The idea that scientific theory is "co-determined" by external social influences is also presented in Gideon Freudenthal, Atom and Individual in the Age of Newton (Dordrecht: D. Reidel Publishing, 1986).

3. Shapin and Schaffer, 14.

4. Ibid, 65.

5. See R.G. Collingwood, The Idea of Nature (New York: Galaxy, 1960; first published 1945) for a chronology of the most significant shifts in world-view and the associated implications to science.

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