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Alchemy and Newton's Philosophy of Nature

Pierre J. Boulos

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ABSTRACT

Alchemy and Newton's Philosophy of Nature

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Philosophers of Science have maintained that Newton's philosophy of nature is an example of a good scientific paradigm. Newton, it is claimed, is a founding member of that movement which brought about the scientific revolution. Newton has been presented as an ideal towards which all true scientists ought to aim in their quest to reveal the secrets of nature. Despite these claims this thesis proposes that Newton's esoteric projects were important to him. Furthermore, these projects helped him in forming some of his scientific theories. It will therefore be maintained that Newton's alchemy was as important to him as were his scientific endeavours. To show that this is true, the thesis is divided into three parts. The first part examines the topic of Newton and Empiricism. The second part is an examination of the main circumstantial evidence for Newton's interest in the esoteric. The third and final part is the examination of the main direct evidence connecting Newton and the esoteric. These findings illustrate the rôle of the mystical elements of Newton's thought in his scientific work. The results suggest that the study of alchemy is invaluable for understanding the context in which Newton made his chief scientific discoveries.

ACKNOWLEDGEMENTS AND DEDICATION

I would like to thank Professor Maben Poirier for his patience, persistence, and ideas. The many hours spent in discussion with Professor Poirier will have a lasting influence on me. I would also like to thank Professor Désirée Park for her insights, help, and for making my first course at Concordia a memorable experience. Without this support and direction this project would not have been possible.

I dedicate this project to the two persons who have had to deal with the process of watching a loved one write a thesis. I do not envy Andrea and Chadaï for their experience with my frustration, however I thank them for their unconditional support.

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INTRODUCTION

For well over a century, Sir Isaac Newton has been characterized by mainstream Anglo-American philosophers of science as a founding practitioner of what we have come to understand as the methods of the natural sciences, and more often than not, he has been viewed as an outstanding and perhaps even unique example of "the great natural scientist." In fact, more frequently than perhaps anyone cares to admit, he has been represented as the ideal towards which all true scientists ought to aim in their quest to reveal the secrets of nature. In truth, it must be said there are many scholars who would argue today that he was the first natural philosopher deserving of the name "scientist," and this is largely because he is said to have had virtually no interest in things transcendent or metaphysical, and generally to have been little preoccupied with matters that cannot be known empirically. It was his empiricism that distinguished him, and that eventually led him to reveal the deepest mysteries of the natural order, it is said. It was his fidelity to things known sensually that made him who he was, and that in the end showered on him everlasting fame. To his great credit, we are told, Newton showed none of the concern for matters spiritual and/or metaphysical that had been so typical of the would-be scientific thought of the Middle Ages and the Renaissance -- a concern that was largely responsible for the confused state of affairs in which natural philosophy found itself early on in its development.

However, lately, there are some who would dispute this reading of Newton, and specifically question whether he was a person who was empirically inclined in the sense in which this expression is currently understood (even if we allow for a generous understanding of the term "empirically"). Indeed, it is not unusual to hear it said today that Newton had little to do with empiricism in the sense in which contemporary philosophers of science define and understand this term. Newton's approach to the study of physical reality, it is increasingly argued, was not driven by anything like a great concern to be empirical, nor was it motivated by anything like a desire to avoid the pitfalls of metaphysical thinking, as is widely claimed. In actual fact, he was moved to explore the complexities of the natural order by quite a different concern, and this gave to his thought a specifically late Renaissance flavour. Now, as a consequence of this, and to the extent to which it is true, a good many scholars are no longer certain that Newton was a direct ancestor of the modern scientist. In fact, it is increasingly being argued that in terms of both his avocational and vocational interests, Newton demonstrated a penchant that can be defined as scientific only if we employ the vaguest of criteria. In this connexion, it is interesting to note that it is no longer as clear as it once was what Newton's concerns were, that is, was Newton a theologian interested in science, or was he a scientist interested in theology and the Bible? Newton's interest in the Bible, and more specifically in the Book of Daniel and Revelations, chiliastic works, to say the least is notable. The amount of time he spent researching these two works, when compared to the time spent on the study of nature, is so well known today that it behooves the person who thinks of him as primarily a natural scientist to explain himself. But, of course, it is not only Newton's avocational concerns that cause one to wonder about the intensity of his scientific commitment and interest. It is increasingly recognized that his scientific work reveals his various ideas and thoughts. These, of course, can hardly all be said to have had their origin in the empirical world, as many contemporary philosophers of science might be tempted to conclude. And so it seems that the connections between Newton's avocational and vocational concerns were much more profound than was at first assumed. All of this will be argued in the course of this thesis.

It will be my object in this thesis to do two very simple and straightforward things: In Part One I shall articulate, in as clear a fashion as possible, the essence of what I understand to be the conventional reading of Newton. This includes who he was and depends very much on our Twentieth Century sense of what is involved in thinking scientifically. The them of Part One will be examined in the first chapter. In Part Two, I shall attempt to draw together the main circumstantial and direct evidence for my opinion that

Newton cannot be seen as a progenitor of the scientific method and of scientific thinking without qualification. This is especially the case if by "scientific thinking" we mean what mainstream contemporary philosophers of science mean. This theme will be investigated in Chapters II and III.

CHAPTER I

Empiricism and Isaac Newton

I. EMPIRICISM:

It is something in the nature of a truism today to say that the natural sciences are empirically oriented.[1] To this is often added the claim that the progress we have seen in the sciences of nature over the past two to three hundred years is due almost totally to the decision taken by natural philosophers some centuries back to be concerned strictly with what was knowable to them through the senses.

One mark of the scientific revolution is that, to this day, science is a leading method by which one attains truth. The achievements of science are a testament to this. The revolution in science that took place during the sixteenth and seventeenth centuries allowed seekers after knowledge to search for truth in a material world. The search for truth in the material world, as opposed to the divination of regularities of the objects of pure thought, was promoted by a school of thought called empiricism. The objections against metaphysics were, perhaps, given their most lucid formulations in the writings of David Hume.

> Here, indeed, lies the justest and most plausible objection against a considerable part of metaphysics, that they are not properly a science, but arise either from fruitless efforts of human vanity,

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[1]This claim does not preclude view(s) of science which would complement science's empirical orientation. That is, contemporary philosophy of science examines various aspects of science. These include, amongst others, the processes through which theories are formulated and justified.

which would penetrate into subjects utterly unaccessible to the understanding, or from the craft of popular superstitions, which, being unable to defend themselves on fair ground, raise these entangling brambles to cover and protect their weakness.[2]

When thinking about empiricism one tends to think, above all, of the British empiricists of the seventeenth and eighteenth centuries, although one can trace the empiricist thesis back to Aristotle and Epicurus.[3]

In its weakest form, empiricism is the doctrine that the senses do provide us with knowledge in some sense of the word. The thesis can be generalized in the following form: All knowledge comes from experience. Since science is the method by which one attains truth, its method must be based on experience. In the words of Ernst Mach: "Physics is experience, arranged in economical order."[4]

The objects of experience are collectively known as sense-data. Since scientific knowledge comes from experience, it follows that scientific knowledge is founded upon the data

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[2]David Hume, *An Inquiry Concerning Human Understanding* in *On Nature and the Understanding*, edited by Anthony Flew (New York: Collier Books, 1962), p.174.

[3]Aristotle claims in Book Alpha of the *Metaphysics*: "Experience, though it seems quite like scientific knowledge and art, is really what produces them; for, as Polus rightly says, experience brought art, and inexperience, luck." *Metaphysics* 981a, translated by Richard Jope (Ann Arbor, Mich.: The University of Michigan Press, 1952), p.3.

[4]Ernst Mach, "The Economy of Physical Theory," in B.A. Brody and N. Capaldi, eds. *Science: Men, Methods, Goals* (New York: W.A. Benjamin, 1968), p. 19.

for the senses. To this end, sense-data are the most basic constituent elements of scientific knowledge. The sense-data are known through observation and experiment which, ostensibly, make use of the senses.[5]

The scientist is, however, interested in laws and theories, not in this or that fact. A sense-datum, as I understand the term, is highly specific. Unlike this, a theory in science is a formal system that obeys the rules of logic, and that articulates the relationships that hold between the facts of physical reality. In other words, scientific theory is a summary[6] of how empirical events behave. In the words of Albert Einstein:

> Science is the attempt to make the chaotic diversity of our sense-experience correspond to a logically uniform system of thought. In this system single experiences must be correlated with the theoretic structure in such a way that the resulting coordination is unique and convincing.
> The sense-experiences are the given subject-matter. But the theory that shall interpret them is man-made.[7]

Theories, insofar as they are summaries of the behaviour of

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[5]The term 'sense-data' varies greatly amongst philosophers who use the term. I take 'sense-data' to mean only sensory information in its most literal sense.

[6]By "summary" I simply mean the following. One may look at theories as economically describing a whole host of observable events. This also means that specific instances of these events will also be included in this summary.

[7]Albert Einstein, "The Fundaments of Theoretical Physics," in Herbert Feigl and May Broderick, eds., *Readings in the Philosophy of Science* (New York: Appleton-Century-Crofts, 1953), p.253.

the events of physical reality, are comprised of logically ordered scientific statements. These statements, collectively, describe the relationship that holds among the observable facts. This means that the component parts of a scientific theory are all susceptible to being reduced to empirical facts or relations among empirical facts. In other words, the fundamental theoretical notions are reducible to the data received by the senses or relations among the data. This thesis is characterized by its use of translation. All theoretical terms, such as "atom," and all statements containing theoretical terms can be translated, in principle, into statements that refer only to commonly observable entities. In short, theories are convenient summaries of a whole host of data.

Empirical statements are either true or false. The truth value of an observational statement lies in whether or not it can be verified or falsified. It is the sense-data that either verify or falsify a scientific claim. According to this school of thought, the scientist always has recourse to the sense-data. Modern empiricists, however, do not maintain the more radical position which was in vogue in the first quarter of this century that scientific theories must always be reducible to their constituent elements. For example, scientific claims pertaining to the so-called phenomenon of the black hole are hardly in a position to be verified or falsified by sense-data since no one has been able to observe the workings of a black hole.

For such reasons as these, it is the view of the modern empiricist that scientific claims are synthetic claims. Unlike analytic claims in which the concept of the predicate is contained within the concept of the subject, synthetic claims are about matters of fact, and hence are susceptible of being verified or falsified. Since all propositions fall into two categories, synthetic or analytical, and scientific laws are universal propositions, it follows that scientific laws are not known *a priori* but rather *a posteriori*. That is, since scientific claims are, in principle, reducible to sense-data, the claims could not be known prior to or independently of experience since this would be a contradiction. David Hume once claimed that no matter which level of generality we wish to ascribe to scientific propositions, we cannot go beyond the confines of experience.

> And though we must endeavour to render all our principles as universal as possible, by tracing up our experiments to the utmost, and explaining all effects from the simplest and fewest causes, it is still certain we cannot go beyond experience; ... .[8]

Consequently, it is the view of modern empiricism that the laws of science are descriptive of physical reality and are derived through a process of observation and induction.

The passage cited from Hume along with the foregoing

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[8]David Hume, *A Treatise of Human Nature* contained in *On Human Nature and the Understanding*, edited by Anthony Flew (New York: Collier Books, 1962), p.174.

discussion illustrate the modern empiricist claim that the empirical nature of science has built into it a critical mechanism. The practice of modern science is critical in the sense that it allows for the revision of any part of it. That is, since scientific claims rest upon experience, there is no truth attached to hypotheses in science. Hypotheses or conjectures are preliminary. We acquiesce in these claims only after they have been critically verified or falsified. The critical aspect of science also accounts for the superseding of one theory by another. In short, the critical nature of science is a positive feature in that scientific discovery arises out of it.

The critical aspect of science, it is said, also guarantees the distinction between science and non-science. That is, science is a leading vehicle by which modern humanity secures truth. Truth is determined by the corroboration of the claim by the facts. This definition does not admit the types of claims which are not derived through sense-experience. Claims which do not allow for verification or falsification, at least in principle, such as are found in metaphysics, have no reference to truth. These claims do not belong to the domain of science.[9]

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[9]Modern empiricism, especially in the guise of logical positivism, has often debated the nature of trans-empirical claims. That is, are trans-empirical claims nonsense, gibberish, or simply just not admissible in science? The radical empiricist wished to found all knowledge, and consequently every avenue of human communication, on the ideal of science. In such an instance, trans-empirical claims are said

II. ISAAC NEWTON: THE EMPIRICIST:

Newton, it is argued, is a charter member of the great movement to found the study of nature on sense knowledge, and on what is knowable empirically. From the inception of his interest in science, it is said, he demonstrated nothing but a complete devotion to the facts of nature, and had little or no tolerance for empirically unfounded speculation. Examples of Newton as founding member of the empiricist clan abound in the literature.

> Newton was seen as the harbinger of an inductive, experimental learning which proceeded by a gradual ascent from the particulars of observation to general laws which were true and virtually incorrigible. What Bacon had prophesied in the way of an inductive interpretation of nature, Newton had brought to fruition.[10]

In the preceding section we began our discussion of empiricism with a discussion of the rôle sense-data play in science. We saw that the sense-data are the constituent elements of science and scientific theory. This, we are told, is also true of Newton, the champion of science. In his "Foreword" to the modern edition of Newton's *Opticks*, we witness Albert Einstein making the following comment:

> Nature to him [Newton] was an open book,

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to be gibberish. In any event, the common notion amongst empiricists is that trans-empirical claims are alien to the language of science.

[10]L.L. Laudan, "Thomas Reid and the Newtonian Turn of British Methodological Thought," in Robert E. Butts and John W. Davis, eds., *The Methodological Heritage of Newton* (Toronto: The University of Toronto Press, 1970), p.104.

> whose letters he could read without effort. The conceptions which he used to reduce the **material of experience** [emphasis mine] to order seemed to flow spontaneously from experience itself, from the beautiful experiments which he ranged in order like playthings and describes with an affectionate wealth of detail.[11]

The theme of Newton's empiricism occurs throughout the literature.[12] A classic, and probably a standard way of characterizing Newton came from the pen of Edwin Burtt. In his classic work, *The Metaphysical Foundations of Modern Physical Science*, Burtt tells the reader that not only was Newton a foremost mathematician, Newton was equally a diligent empiricist. "It is obvious," he claims,

> to the most cursory student of Newton that he was as thoroughgoing an empiricist as he was a consummate mathematician. Not only does he hold, with Kepler, Galileo, and Hobbes, that "our business is with the causes of sensible effect," and insist, in every statement of his method, that it is the observed phenomena of nature that we are endeavouring to explain; but experimental guidance and verification must accompany every step of the explanatory process.[13]

What Burtt had in mind was a passage from the *Opticks* in which

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[11]Albert Einstein, "Foreword" to Isaac Newton, *Opticks, or a Treatise of the Reflections, Refractions, Inflections and Colours of Light*. Based on the fourth London edition of 1730. (New York: Dover Publications, 1952), p. lix.

[12]Newton, it has been maintained by philosophers of science, is an empiricist just in the sense that he sought to reveal the truths about nature through an analysis of experience. Newton's project, on this account, can be seen as a desire to explain physical reality.

[13]E.A. Burtt, *The Metaphysical Foundations of Modern Physical Science* (Garden City, N.Y.: Doubleday, 1955), p.212.

Newton describes the method by which natural philosophy should proceed. In this passage Newton, almost in the language of twentieth century philosophers of science, explicitly discusses the rôle of verification.

> And if no Exception occur from Phænomena, the Conclusion may be pronounced generally. But if at any time afterwards any Exception shall occur from Experiments, it may then begin to be pronounced with such Exceptions as occur.[14]

From this we are to gather that Newton's concern was focused on the phenomena.

It comes as no surprise, then, to hear that Newton was only concerned with the facts of experience. His interests lay not in the "trans-empirical," but solely in physical reality. We are led to believe Newton's thought is solely directed to explaining the phenomena, as well as reasoning from these phenomena. In this we hear Ernst Mach giving high praise to Newton.

> Newton's Reiterated and emphatic protestations that he is not concerned with hypotheses as to the causes of phenomena, but as simply to do with the investigation and transformed statement of *actual facts* -- a direction of thought that is distinctly and tersely uttered in his words 'Hypotheses non Fingo' -- stamps him as a philosopher of the highest rank.[15]

Newton is a philosopher of the highest rank because, it is said, he repeatedly refused to dabble in metaphysics. And as

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[14]*Opticks*, p.404.

[15]Ernst Mach, *The Science of Mechanics* (Chicago: The Open Court, 1946) p.193.

we have seen, claims regarding the trans-empirical are not the domain of science. Newton, as a paradigm of a scientist, would not, according to the classical conception of him, discourse of God within the realm of science. And recently, a physicist from Cambridge has reiterated this conception of Newton:

> Unlike Descartes, Newton did not make the relationship of God to his creation one of his subjects of inquiry, but instead concentrated more completely on the movement of material things through space.[16]

With increasing authority, which has been maintained for the last two and a half centuries, we are led to believe that Newton was the ideal empiricist of his age. On the basis of the foregoing, one could hardly be criticized for believing that Sir Isaac Newton was even a twentieth century empiricist before his time. But was he?

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[16]Anjam Khursheed, *Science and Religion* (London: One World Publ., 1987), p.37.

CHAPTER II

Newton and the Esoteric

Circumstantial Evidence

Alchemy, from antiquity to after Newton's time, was as near to chemistry as one could get. The alchemist was well equipped with a laboratory and instruments for observation. In short, the practice of observation and experiment was characteristic of the best alchemist. Seventeenth century alchemists often spoke of alchemy as an art, the art of separating the pure from the impure. Yet alchemy was more than this. Nicholas LeFèvre placed philosophical chemistry above all else.

> Chymistry is nothing else but the Art and Knowledge of Nature itself; that it is by her means we experience the Principles, out of which natural bodies do consist and are compounded; and by her are discovered unto us the causes of their sources of their generations and corruptions, and of all the changes and alterations to which they are liable... .[17]

The alchemist thinks of this science as the "true Key of Nature." This science must examine the whole course of nature: "that which is below is like that which is above and that which is above is like that which is below."[18] This theme is given an explicit formulation in the writings of the famous Italian alchemist John Baptista Porta (c. 1535-1615).

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[17]Quoted in Allen G. Debus and Robert Multhauf, *Alchemy and Chemistry in the Seventeenth Century* (University of California, Los Angeles: William Andrews Clark Memorial Library, 1966), p. 7

[18]These lines come from the *Emerald Tablet* written by Hermes Trismegistus. I have included a translation of this work by Newton in the Appendix.

In his *Magia Naturalis* Porta noted that

> Magick is nothing else but the survey of the whole course of nature. For whilst we consider the Heavens, the Stars, the Elements, how they are moved, and how they are changed, by this means we find out the hidden secrecies of living creatures, of plants, of metals, and of their generation and corruption; so that this whole science seems merely to depend upon the view of Nature.[19]

It seems that if one is to understand the sixteenth and seventeenth century mechanical philosophers, astronomers, and mathematicians[20] who showed evidence at one time or another of an interest in alchemy or another phase of chemistry, then one should be willing at least to consider the possibility that this interest may stem not necessarily from a desire on their part to transmute base metals into gold, but from a very understandable desire on their part to examine the claims of the chemical philosophers. The chemical philosophers, or alchemists, suggested that the proper key to all nature was to be found in their experimental science.

In this chapter I shall present the evidence which, if taken seriously, will help to prove that Newton cannot be seen as having been the progenitor of what has come to mean the

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[19]John Baptista Porta, *Natural Magick* (London: Thomas Young and Samuel Speed, 1658), p.2. Quoted in Allen G. Debus, *The Chemical Philosophy*, Vol. I (New York: Science History Publications, 1977), p.34.

[20]I am here interested in the work of Newton. Others who would fall into the category described above would include John Dee, Giordano Bruno, Johannes Kepler, Robert Boyle, Isaac Barrow, and John Locke to name a few.

scientific method. It is understandable that Newton examined the writings of the alchemists for in them one finds claims that the practice of alchemy contains the true secrets of nature. For this reason, the evidence provided here and in the next chapter must be seen as a respectable pursuit of an aspiring natural philosopher. In order to prove that Newton cannot be seen as having been the progenitor of what has come to mean the scientific method, I have gathered the main evidence from Newton's avocational interests to form the body of this chapter. The evidence should be taken as proof for the esoteric and its rôle in Newton's thought and life.

(i) *Newton's Library:*

Newton died intestate in 1727. After his death six large bookcases filled with books were sold. It is clear that Newton possessed a very large library. These bookcases and their books were bought by John Huggins, warden of Fleet Street Prison, for £300.[21] Huggins gave the collection to his son Charles, rector of Chinnor from whom it passed to Dr. James Musgrave for £400. The library remained in the Musgrave family until it was dispersed in 1920. The historian of science, R.J. Forbes, examined the lists prepared by both Huggins and Musgrave and, from which, tabulated his results in

[21]It has been brought to my attention by Professor Park that this sum is very large considering that the purchase occurred during the first half of the eighteenth century.

his article "Was Newton an Alchemist?".[22] A rough tabulation of the titles reveals the following statistics:

CATEGORY	# OF TITLES	% OF LOT
Theology & Philosophy	515	32
History & Chronology	215	14
Classical Authors	182	11
Chemistry, mineralogy, & alchemy	165	10
Mathematics, physics, & astronomy	268	16
Geography	76	5
Philology,grammar,& misc.	95	6
Medicine, biology, & husbandry	52	3
Coinage, numismatics	35	2
Technology	18	1
	1621	100%

Even a cursory glance at the above tabulation will reveal some valuable information. (a) What is astonishing is that the titles in the subjects in which Newton was always held to be the supreme practitioner amount to only sixteen percent of the total of 1621 volumes. (b) Furthermore, from this list it is apparent that the "chemical" and "alchemical" volumes account

[22]R.J. Forbes "Was Newton an Alchemist?", *Chymia* 2 (1949):27-36.

for 10% of the total. (c) This figure, however, does not include the "three dozen of small alchemical books" and a large part of the "above a hundredweight of Pamphlets and Wast Books" reported by Huggins, the original purchaser of Newton's library.[23] (d) The first four categories account for two thirds of Newton's entire library. It could hardly be said that these titles reflect Newton's scientific genius. (e) Added to this list we must include the large number of copies of alchemical works in Newton's own hand, which were either copied by Newton or composed by him, and were found among his papers after his death. This corpus of alchemical writings totalled some one and a third million words.[24] (f) Not only did the esoteric writings hold a sizable place in Newton's library, but historians of science have also realized that Newton held one of the largest private collections of alchemical literature in the seventeenth century.[25]

A related point is that Newton's private collection was not merely for show. Newton collected books seriously in order to glean knowledge from them. Moreover he read nearly every item in his collection, as the marginal comments reveal.

(ii) *Familiarity with Alchemical Literature:*

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[23]Ibid, p.29.

[24]Lynn Thorndike, *A History of Magic and Experimental Science*, Volume VIII, (New York: Columbia University Press, 1958), p. 589.

[25]B.J.T. Dobbs, *The Foundations of Newton's Alchemy or "The Hunting of the Greene Lyon"* (Cambridge: Cambridge University Press, 1975), p.49.

It cannot be doubted that Newton was quite familiar with the alchemists. It should be remembered that during the seventeenth century the distinction between alchemy and chemistry was not as clearly drawn as it is today. Alchemy was a legitimate area of study. This distinguishes Newton from those who abuse alchemy. The latter merely attempted to produce gold from the base metals to further their own riches. Newton often chided them for being concerned with making gold for profit. We should not infer from this that his views regarding alchemy were negative. Newton was a seeker after knowledge, and he went to great trouble in his search for truth. This is apparent from his alchemical interests. He knew well enough the importance of the *Corpus Hermeticum*[26] -- he even translated into English and commented on the most famous of all pieces of alchemical literature, the *Emerald Tablet* of Hermes Trismegistus.[27]

(iii) *The Purchase of Laboratory Equipment:*

Newton's scientific *annus mirabilis* has often been said to be 1664. It has been remarked that at the tender age of twenty-two, Newton first discovered universal gravity, his theory of fluxions, and his optical theory. No more than four years after this however, at the age of twenty-six he bought

[26]Hermes Trismegistus, whose so-called writings form the *Corpus* is often believed to be an ancient Egyptian priest. Some historians have linked Hermes to Moses in that they were contemporaneous. In any event it is widely recognized that the alchemical fraternity owes its creed to Hermes.

[27]This translation is included in the Appendix.

chemical retorts, a furnace, and books on alchemy.[28] Given the fact that Newton did not publish the *Principia* until 1687, it is obvious that he carried out alchemical experiments prior to the publication of this great work.

(iv) *Prophecies prior to Principia:*

Newton's early years saw him immersed deep in thought. As we have pointed out, 1664 marks the year in which he made the scientific discoveries for which we know him. By 1680, however, Newton had already shown his maturity with respect to Biblical interpretation.

It is common opinion that Newton was a religious man. The importance of his religious ideas for his scientific thought has, until recently, been largely neglected. Newton, apparently, died with many secrets. Among them were his anti-Trinitarian views. He was, however, known for his interpretations of the book of Daniel and his knowledge of Chronology. This should not come as a surprise since Newton came in contact with Isaac Barrow, whom he replaced as the Lucasian Professor of Mathematics, and Henry More. The latter, of course, was one of the leading figures of the group of thinkers known as the Cambridge Platonists. Both men held deep religious convictions and had an immense influence on the young Newton. As we have already noted, by 1680 Newton had

[28]David Castillejo, *The Expanding Force in Newton's Cosmos as Shown in his Unpublished Papers* (Madrid: Editiones De Arte Y Bibliofilia, 1981), p. 13.

already shown a great deal of maturity in the area of Bible exegesis. A letter from Henry More to John Sharpe shows that Newton, at thirty-seven, was fairly set in his interpretation of the prophecies of the Apocalypse.

> As Dr. Burton at the Commencement, so I remember you either here at the time or at London before asked me about Mr. Newton and my agreement in Apocalyptical Notions. And I remember I told you both, how well we were agreed. For after reading the Exposition as coherent and perspicuous throughout from beginning to the end, but (by the manner of his countenance which is ordinarily melancholy and thoughtful, but then mighty lightsome and cheerful, and by the free profession of what satisfaction he took therein) to be in a manner transported. So that I took it for granted, that what peculiar conceits he had of his own had vanished. But since I perceive he recoils into a former conceit he had entertained, that the seven Vials commence with the seven Trumpets, which I always looked upon as a very extravagant conceit, and he will not have the Epistles of the Seven Churches to be a prophecy of the state of the Church from the beginning to the end of the world. He will also have the three days and half of the witnesses lying slain, to be three years and a half after their mournful witnessing ... .
> *Your affectionate friend to serve you*
> *Hen. More*[29]

More goes on to claim that he disagrees with Newton with regard to the prophecies but that, nonetheless, they are good friends and that they are open to disagreement. Newton spent a great deal of time interpreting the Apocalypse as well as the book of Daniel. The choice of these texts indicates

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[29]David Castillejo, *The Expanding Force*, p.14.

Newton's preoccupation with the esoteric. Given the fact that theological books outnumbered any other type of book in the Newton library, it would be unfair to his genius and it would misrepresent his range of interests simply to dismiss his interpretations of the more esoteric Biblical passages as an exercise of the intellect.

(v) *Alchemical Experiments and the Publication of the Principia*:

The year 1681 marks the time during which Newton performed his most enthusiastic alchemical experiments. Newton was a diligent worker who would compromise sleep for work. He broke off the alchemical experiments during 1684-6 to write the *Principia*. In and of itself, this event is not terribly revealing with respect to this thesis. Out of context it would appear that the "scientific" overcame the "esoteric" during this time. There are, however, two related incidents which challenge this notion.

First, after delivering the manuscripts for the first edition of the *Principia* to the astronomer Halley in early 1686 Newton returned at once to his alchemical experiments. His notes reveal the following entry:

> Apr. 26 1686. Wednesday. I sublimed spirit of Spelter[30] (which two years before had been dissolved in distilled spirit of Antimony...)[31]

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[30]Spelter is commercial zinc, about 97% pure with lead and other impurities.

[31]Ibid.

It is interesting to note that Newton carried out an experiment he began just prior to the writing of the *Principia*.

Secondly, Humphrey Newton, Newton's amanuensis from 1684 to 1689, has indicated that astronomy and mathematics were only a part, and perhaps not the most absorbing part of Newton's preoccupations. This, it should be recalled, was during the years in which the *Principia* was written! For Humphrey Newton claims that

> about six weeks at spring and six weeks at the fall, the fire in the elaboratory scarcely went out, which was well furnished with chemical materials as bodies, receivers, heads, crucibles, etc. which was (sic) made very little use of, the crucibles excepted, in which he fused his metals; he would sometimes, tho' very seldom, look into an old mouldy book which lay in his elaboratory, I think it was titled Agricola de Metallis, the transmutating of metals being its chief design, for which antimony was a great ingredient.[32]

(vi) *Isaac Barrow and Experimentation*:

I have already mentioned that among the more prominent influences felt by Newton, Barrow and Henry More stood out. With respect to the former, Barrow was a very religious man as well as a sound mathematician. Newton's mature scientific methodology of compounding experimentation with mathematics was probably derived from Barrow. Barrow, it is said, has claimed that, "You get your eyes to help your ears: you make

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[32]Quoted in R.J. Forbes, "Was Newton an Alchemist?", p.31.

experiment the companion of reason."[33]

The combination of experimentation and mathematics is not all that could have been imported from Barrow. It is probably through Barrow that Newton came into contact with neoplatonic teaching. As we will see in the next chapter, where we will cite direct evidence in support of our thesis, the platonism of the Cambridge school, with its considerable interest in matter-spirit relationships, was in direct opposition to the then-popular mechanistic teachings of the Cartesians. It was, furthermore, well known at the time that the Cambridge Platonists were sympathetic to alchemy and Hermetic philosophy. Barrow, no doubt, would have conveyed his opposition to strict mechanism to his favourite pupil, Newton. "And from Barrow's own words, taken in context and quoted above, he quite clearly conceived alchemical experimentation to have scientific status equal to that of experimental anatomy and botany, if not actually superior to them."[34] In 1675, at the age of 45 and two years prior to his death, Barrow was actively conducting experiments with Newton, as evidenced by this letter from John Collins to James Gregory:

> ... Mr. Newton (whome I have nott writt to or seene this 11 or 12 Months, not troubling him as being intent upon Chemicall Studies and practices, and both he and Dr. Barrow &c beginning to thinke mathcall Speculations to grow at least nice and dry, if not somewhat barren)

[33]Dobbs, *Foundations*, p.100.

[34]Ibid.

. . . .[35]

(vii) *Newton's Silence*:

To most critics, Newton's silence with respect to alchemical publications suggests his dismissal of the esoteric in favour of his scientific publications. This would seem obvious only if one is not acquainted with Hermetic teachings. These teachings were the secrets which no true alchemist would impart. That is, the Hermetic teachings are those derived from the *Emerald Tablet* and the other works of Hermes Trismegistus. These works are written in a mystical tone and consequently, they are unintelligible to the modern reader. The alchemists formed a fraternity[36] in which it was enjoined on its members not to reveal its secrets. Newton, it should be remembered, was also silent when it was appropriate to acknowledge the works of others. In fact, he has often been charged with plagiarism, even during his lifetime. Most notably, Leibniz, Hooke, and Flamsteed all levelled charges of plagiarism against Newton.

> Of late Newton has been chided for seldom indicating the previous literature and experimentation on the subject in hand, and those from whom he may have received

[35] Isaac Newton, *The Correspondence of Isaac Newton* 7 vol., ed. H.W. Turnbull et al. (Cambridge: Published for the Royal Society at the University Press, 1959-78), Vol. 1, p.355.

[36] By this I am not alluding to the famous Fraternity of the Rosy Cross, or, the Rosicrucians. Although this group, which supposedly was started with Giordano Bruno and John Dee, was formed around alchemy, I am simply referring to the community formed by the alchemists for the simple reason that they shared a common task and a common goal.

> suggestion. This, if true, is probably another magical trait in him, continuing the method of secrecy and exaggeration of one's own feats and performances.[37]

Historians of science have often misrepresented Newton and his secrecy. Amongst the widely held view supporting the thesis that Newton was secretive because he, himself, realized the shortcomings of alchemy, one finds the scholars Marie Boas Hall, A. Rupert Hall, and I.B. Cohen. What these scholars, especially the Halls, fail to realize is that Newton's familiarity with Hermetic teaching necessarily dictated his silence. Furthermore, his alchemical work often bears a resemblance to his scientific work. The late economist John Maynard Keynes made a similar claim while reflecting on his perusal of Newton's papers.

> All his unpublished works on esoteric and theological matters are marked by careful learning, accurate method and extreme sobriety of statement. They are just as *sane* as the *Principia*, if their whole matter and purpose were not magical. They were nearly all composed during the same twenty-five years of his mathematical studies.[38]

Not only was Newton performing alchemical experiments, his writings show him as serious and as devoted to them as to his scientific writings.

Newton, we are claiming, understood quite well the secrecy involved in Hermetic teaching. The "fraternity" of

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[37] Thorndike, *History* vol. VIII, p.600.

[38] J.M. Keynes, "Newton, the Man", in *Essays in Biography*, ed. Geoffrey Keynes (London: Mercury Books, 1961), p. 316.

Hermetic philosophers often couched their writings in riddles and difficult jargon. It must be understood that the subject matter of the alchemists could land in the hands of the uninitiated. If it did, dangers may have awaited humanity.[39] Newton obviously felt that he belonged to the élite class of savants. This becomes plain in a letter to the secretary of the Royal Society in which he petitions for a veil of secrecy surrounding the work of Robert Boyle. Boyle, it should be remembered, is often considered to be the father of modern chemistry. In his *Sceptical Chymist* he is said to have attacked the alchemist. This may be the case, however historians of science will often concede that Boyle, like so many of his time, dabbled with alchemy. With respect to the search for the Philosopher's Stone of the alchemist, Boyle may have moved a step closer than his contemporaries. Newton heard of Boyle's results and communicated his wishes to Henry Oldenburg, secretary of the Royal Society. A large portion of this letter is quoted since it supports our discussion of

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[39]Since the alchemist held that he or she can enter nature in order to aid it in purification, it was necessary to keep such knowledge out of the reach of the wicked. That is, the alchemist's quest for the Philosopher's Stone was a religious experience. The knowledge derived from this art is of great importance to humanity since it pertains directly to salvation. The Philosopher's Stone would not only allow us to change the base metals into their purer form of Gold, it would essentially give humanity a pure and perpetual life. For this reason the Philosopher's Stone is often considered to be the same as the Elixir of Life. Obviously something as important as this must be managed by those who are knowledgeable about such matters. Newton's opposition to gold seekers is perfectly understandable in this light.

Newton's knowledge of Hermetic philosophy and its accompanying secrecy.

> Cambridge, April 26, 1676.
>
> Sir,
>
> Yesterday I reading the two last *Philosophical Transactions* had the opportunity to consider Mr. Boyle's uncommon experiment about the *incalescence of gold and mercury*. I believe the fingers of many will itch to be at the knowledge of the preparation of such a mercury; and for that end some will be wanting to move for the publishing of it, by urging the good it may do in the world. But, in my simple judgement, the noble author, since he has thought fit to reveal himself so far, does prudently in being reserved in the rest. ... Because the way by which mercury may be so impregnated, has been thought fit to be concealed by others that have known it, and therefore may possibly be an inlet to something more noble, not to be communicated without immense damage to the world, if there should be any verity in the Hermetic writers; therefore I question not, but that the great wisdom of the noble author will sway him to high silence, till he shall be resolved of what consequence the thing may be, either by his own experience, or the judgement of some other that thoroughly understands what he speaks about; that is, of a true Hermetic philosopher, whose judgement (if there be any such) would be more to be regarded in this point, than that of all the world beside the contrary, there being other things beside the *transmutation* of *metals* (if those *great pretenders* brag not) which none but they understand. Sir, because the author seems desirous of the sense of others in this point, I have been so free as to shoot my bolt; but pray keep this letter private to yourself.[40]

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[40] Quoted in L.T. More *Isaac Newton. A Biography* (New York: Dover Publications, 1934), p.162.

This letter, if any, would prove that the "incomparable Mr. Newton," as Locke called him, was not only aware of Hermetic teachings, but evidently respected them. In passing, it should be noted that Newton alludes to those "great pretenders." By this he meant those alchemists whose sole pursuit was the transmutation of base metals into gold for reasons of profit. Newton realized that for the true magician the transmutation of the base metals into gold was only a part of the profession, it was not the *raison d'être* of alchemy. It is interesting to note that Newton asks Oldenburg to persuade Boyle to keep silent. In his petition Newton foresaw the counter-argument that Boyle's discovery may benefit humanity. The reply is that the shroud of secrecy surrounding alchemy is precisely for the reason that the sacred secrets should not fall into the hands of the ignorant. In effect, and this will be a theme in the second section of this chapter, Newton believed in a *prisca sapienta*. The true magician cares for the world in such a way that the sacred secrets discovered will be used to protect the innocent. God reveals these secrets only to a few. This notion of an ancient wisdom passed down through the ages is another influence of the Cambridge Platonists upon Newton.

(viii) *Boyle and the "Red Earth"*:

A matter related to the silence Newton wished Boyle to practice is the so-called procurement of a red earth by the latter. Newton's attitude towards alchemy appears to have been fundamentally *en rapport* with alchemical concepts. He maintained a balanced outlook on the possibility of bringing to fruition the Hermetic claims of transmutation although in accordance with his own interpretation of the esoteric process. That his interest in Boyle's experiments continued unaffected for several years is revealed by his correspondence with John Locke. On 26 January, 1691-2 he wrote to Locke and added the following postscript:

> I understand Mr. Boyle communicated his process about the red earth and Mercury to you as well as to me, and, before his death, procured some of that earth for his friends.[41]

Within three weeks Newton communicated once again with Locke, saying:

> ... Mr. Pawling told me, you had writ for some of Mr. Boyle's red earth, and by that I knew you had the receipt.[42]

Something should be mentioned here with respect to Boyle because the communication between Locke and Newton will reveal the latter's attitude towards alchemy. Robert Boyle died 30 December, 1691. He was probably the most distinguished natural philosopher of his day. Boyle, like Newton was an ardent alchemist and had convinced himself that he had come upon a

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[41]Newton's letter to Locke, 26 January, 1691-2. The passage quoted was added as a postscript and quoted in D. Geoghegan, "Some Indications of Newton's Attitude Towards Alchemy", *Ambix* 6 (1957):103. Also L.T. More, *Isaac Newton. A Biography*, p.369.

[42]Letter to Locke 16 February, 1691-2. Quoted in Geoghegan, p.103.

recipe for the multiplication of gold by the agency of mercury and some "red earth." It is interesting to note that at his death he left the inspection of his papers to three friends, among whom we find John Locke. And this is the connexion of Locke, Newton, and Boyle. Locke was trying to assess the promise which these papers held and, to this end, he asked for Newton's appraisal. L.T. More tells us that Newton had become somewhat sceptical of the ability to transmute metals but not of the principles of alchemy.[43] Newton, however, was still tempted to try the process, albeit with some caution. Newton also suspected the success of Boyle. Unknown to Locke, Boyle had communicated the discovery to Newton years before and nothing came of it. This communication included the suspicious fact that, while Boyle was professing to give Newton the recipe, he had casually left out a crucial step as the latter soon discovered. In any event, the following letters to Locke reveal Newton's fascination with alchemy, and that he could not give up hope of its truth. These two letters are dated 7 July and 2 August, 1692.

> You have sent much more earth than I expected. For I desired only a specimen, having no inclination to prosecute the process. For in good earnest I have no opinion of it. But since you have a mind

[43] L.T. More, *Isaac Newton*, p.371. More is not at all clear as to what he meant by such a statement. Nonetheless, we have already pointed out that the practice of transmutation is not a sufficient criterion for the practice of alchemy. That is, alchemy cannot be identified solely with the art of transmutation of the base metals into gold. We will come back to this later on.

> to prosecute it I shall be glad to assist you all I can, having a liberty of communication allowed me by Mr. B. in one case which reaches to you if it be done under the same conditions in which I stand obliged to Mr. B., for I presume you are already under the same obligations to him. But I fear I have lost the first and third part out of my pocket. I thank you for what you communicated to me out of your own notes about it.[44]

But apparently Newton had later been informed that all the relevant parts of the recipe were in Locke's possession for, in his following letter he remarks:

> ... I am glad you have all the three parts of the recipe entire; but before you go to work about it, I desire you would consider these things, for it may perhaps save you time and expense. This recipe I take to be the thing for the sake of which Mr. Boyle procured the repeal of the Act of Parliament against Multipliers, [i.e., alchemists] and therefore he had it then in his hands. In the margin of the recipe was noted, that the mercury of the first work would grow hot with gold, and thence I gather that this recipe was the foundation of what he published many years ago, about such mercuries as would grow hot with gold, and therefore was then known to him, that is, sixteen or twenty years ago, at least; and yet, all this time, I cannot find that he has either tried it himself, or got it tried with success by anybody else ... .[45]

From the remainder of this letter it can be gathered that Newton did not doubt that mercury, through this recipe, could be brought to change its colours and properties, but not that

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[44]L.T. More, *Isaac Newton*, p.372.

[45]Ibid. Also in Geoghengan, p.104.

gold could be brought to be multiplied. We have already cited two reasons why Newton doubted its success, but in the letter he also mentions the failure of "a company who were upon this work in London."[46] Nevertheless, he was still willing to try to make mercury grow hot with gold. He enquired whether Locke had any further information regarding the recipe other than the three parts. Obviously Newton was very interested in the possibility of the recipe working. Newton concludes the letter with an intriguing, yet vague, statement:

> In dissuading you from too hasty a trial of this recipe, I have forborne to say any thing against multiplication in general, because you seem persuaded of it; though there is one argument against it, which I could never find an answer to ... .[47]

This last passage is a good side-light to an understanding of Newton's attitude towards alchemy. Newton mentions that he would communicate the "argument against" in a future letter; if he did so it has been lost. In other words it is unlikely that we will ever know of this argument. Two points need to be mentioned with respect to this passage: (a) Newton claims that he has refrained from saying anything against multiplication or transmutation in general. It would seem odd that he would refrain from such a topic only because Locke was persuaded by it. It would seem more likely that Newton held some glimmer of hope in the art of transmutation. In any

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[46]Ibid.

[47]Ibid, p.374.

event, it is safe to say that he was at least interested in the process. (b) He also talks about one argument either against transmutation or against the recipe received from Boyle. It is not at all clear from the text which he meant. Either "horn" would lead us to the same position: namely, Newton obviously has treated the argument with a degree of seriousness as evidenced by the fact that he has not been able to respond to it. More likely, he probably realized that attempting to transmute base metals into gold, as the Multipliers claim they can do, is an exercise in futility. Such a conclusion, however, does <u>not</u> preclude his inclination toward alchemical principles. And this is probably what L.T. More meant in the passage we cited earlier. Again, the subtlety of the distinction being made here will be elucidated later on.

(ix) *Letters to Locke Concerning Scripture*:

Newton's preoccupation with Biblical exegesis is also of interest to us. About the same time that he was communicating with Locke regarding Boyle's red earth, there appeared to be an active interchange between them regarding prophecies from the book of Daniel. Newton further alludes to a short tract entitled *Two Notable Corruptions of Scripture*, published posthumously, in which his religious views regarding the Trinity become apparent. In this correspondence we see Newton very much preoccupied with scripture. On 7 February, 1690-1, Newton writes Locke for two reasons; the first is to enquire about the well-being of Lady Masham;[48] and the second is to invite Locke into a discussion of some of his more "mystical fancies."

> I hope we shall meet again in due time, and then I should be glad to have your judgement upon some of my mystical fancies. The Son of man, Dan. vii I take to be the same with the Word of God upon the White Horse in Heaven, Apoc. xix. and him to be the same with the Man Child, Apoc. xii. for both are to rule the nations with a rod of iron; but whence are you certain that the Ancient of Days is Christ? Does Christ any where sit upon the throne?[49]

One year later Newton inquires about some papers he had sent for publication. The enquiry is a result of a change of mind on Newton's part. Although the papers were to be published anonymously, they could have easily been traced back to him. These papers, to which we have alluded previously, concern the subject of the Trinity. It is concerning this subject that Newton asked Locke in the passage quoted above whether Christ ever is said to sit upon the throne. So on the 16th February, 1691-2 Newton says the following in his letter to Locke:

> I was of the opinion my papers[50] had lain still, and am sorry to hear there is news

[48]Lady Masham was the daughter of Ralph Cudworth, the famous Cambridge Platonist. This fact along with the fact that Newton thought of her as a serious philosopher is further evidence that the Cambridge Platonists did exercise some influence on Newton.

[49]L.T. More, *Isaac Newton*, p.360.

[50]His tract on two corrupt passages in the New Testament.

> about them. Let me entreat you to stop their translation and impression so soon as you can, for I design to suppress them. ...[51]

During Newton's life there were pretty definite rumours of his heterodoxy, as concerned his acceptance of the Doctrine of the Trinity. During this time adherence to the doctrine was important, for one who did not hold it could not hold any position of trust. Newton, being a Protestant, held that scripture was the fountain of faith. He went on to show that the two principal scriptural passages supporting the doctrine of the Trinity do not appear in the original Greek.[52] In short, they were fabrications of the early Roman church, an institution which he hated. For Newton, then, the belief in the Trinity cannot be justified by the Bible. In other words, Newton was anti-Trinitarian.[53] His heterodoxy, however, had to be suppressed since he was pursuing a life in politics and he especially wished to be the Warden of the Mint, a position he eventually attained through the influence of the Mashams. It would appear then that Newton's theological views were tempered somewhat by his desire for power, a desire many had noticed during his lifetime. This does not diminish the importance of theology in his life. He still spent most of

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[51]L.T. More, *Isaac Newton*, p.369.

[52]David Castillejo, *The Expanding Force in Newton's Cosmos*, p.65.

[53]Whether he was Arian, Socinian, or Unitarian is still a subject of some debate.

his time pursuing theological matters. It would not do to posit a dual personality in Newton -- a scientist on one side, a mystic on the other -- since he engaged in all his studies with the same vigour. For him, theology was not a discipline in which a mind tired by the rigour of scientific thinking could relax. On the contrary, Newton was widely acclaimed in his day for his knowledge of divinity.[54]

(x) *Parallel Between Alchemical and Theological Views*:

Newton, it is said, would first and foremost have considered himself a theologian.[55] We gather from the preceding discussion that, at any rate, Newton was largely preoccupied with theological concerns. Theology, for him, was of prime interest. Our cause, however, is not greatly furthered in merely citing this historical fact. Newton was a man who strove for order. His life is a testament to a genius who thought everything out. In this sense, his inclination towards alchemy is supported by his intense preoccupation with theology.

Superficially, alchemy would appear to be concerned with the transmutation of base metals into gold. When one thinks about alchemy one is usually confronted with this image. At

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[54] L.T. More, *Isaac Newton*, p.608

[55] See Frank Manuel, *Isaac Newton, Historian* (Cambridge, Ma.: Harvard University Press, 1963). Also Marjorie Nicolson examines the effect of Newton's *Opticks* in literature in which she makes a similar claim. Marjorie Hope Nicolson, *Newton Demands the Muse* (Princeton: Princeton University Press, 1946).

first glance, the mention of Newton's name usually causes one to be impressed by his scientific contributions, but if we cut through the superficiality we notice something different. In modern times no one has performed as exhaustive and as systematic a study of alchemy as the psychologist C.G. Jung. Jung noticed a parallel between his patients' dreams and the writings of alchemists. They seem to be couched in similar imagery. Jung concluded that one can understand alchemy as an art to satisfy the religious need of an age. Referring to the history of alchemy from antiquity to about the eighteenth century, Jung stresses the following claim:

> The alchemy of the classical epoch was, in essence, chemical research work into which there entered, by way of projection, an admixture of unconscious psychic material. ... Owing to the impersonal, purely objective nature of matter, it was the impersonal, collective archetypes that were projected: first and foremost, as a parallel to the collective spiritual life of the times, the image of the spirit imprisoned in the darkness of the world.[56]

Similarly, the study of nature, for Newton, is secondary to God. If anything, all that this study could do is to show humanity the wonderful creation God has given us. In this respect, the study of nature becomes the satisfaction of a religious need. When drawn out, the similarity between

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[56]C.G. Jung, *Psychology and Alchemy*. R.F.C. Hull, trans. Volume 12 of *The Collected Works of C.G. Jung* (Princeton: Princeton University Press,1953) p. 476.

alchemy and the philosophical study of nature is striking.

Newton's eagerness for alchemical manuscripts, as we saw in the first part of this chapter, and his hoarding of dozens of them can be explained in the following manner. They, first of all, represent his interest in their chemical hints and allusions. Secondly, they are also connected to his "heretical" beliefs. For, like Newton, the alchemists believed in a kind of pristine religion (*prisca sapienta or theologica*) undefiled by the elaborate dogmas of the Roman church. And like himself the alchemists were subject to punishment for heresy if discovered. In the words of John Maynard Keynes:

> Very early in life Newton abandoned orthodox belief in the Trinity. ... He was rather a Judaic monotheist of the school of Maimonides. He arrived at this conclusion, not on so-to-speak rational or sceptical grounds, but entirely on the interpretation of ancient authority. He was persuaded that the revealed documents [the Bible] give no support to the Trinitarian doctrines which were due to late falsifications. The revealed God was one God. ... But this was a dreadful secret which Newton was at desperate pains to conceal all his life.[57]

Newton must have believed that in alchemical writings there lay hidden a religious expression which was very close to his own belief. Before Protestantism could speak out openly, the alchemists must have seemed to him like the early

[57]Keynes, "Newton, the Man", p.316.

protestants against Romanism.[58] He believed that alchemy in its symbolic search for rebirth and humanity's perfection held the true soteriological secret, which had been lost in the gross practices of the church. The secrets to salvation are what every good Christian should know. Newton, as a good Christian, endeavoured to know such secrets.

[58]It is not surprising that, after all, alchemy has often been associated with gnosticism which, as we all know, has been secretive in the face of the Roman church. A connexion between gnosticism and Newton's metaphysics is beyond the scope of this thesis however.

CHAPTER III

Newton and the Esoteric

Direct Evidence

We have seen that Newton maintained an active interest in non-scientific matters. These interests are avocational only in relation to his scientific occupations. Newton's interest in these subjects was of a serious nature. I will now provide evidence for an even stronger claim.

To suggest that Newton was a magical scientist requires two tasks to be accomplished: (a) the examination of a scientist performing non-scientific projects of an esoteric nature, and (b) the examination of the magician performing scientific tasks. The former we have shown in the preceding chapter. Our aim, at this juncture, is to present and elucidate the magical elements in Newton's scientific oeuvre. With this accomplished we will then be able to unite both sets of evidence in order to state conclusively that Newton was a magical scientist. To the direct evidence we now turn.

The circumstantial evidence was largely presented in a historical fashion. Contrary to this, the direct evidence will be based on the interpretation of texts. Generally, the material examined will be Book III of the *Principia* in which Ne ton describes his "System of the World." It is in this book that Newton gives himself leave to "philosophize." Of all the parts of the *Principia* it is perhaps here that Newton's project becomes less mathematically technical and more philosophically interesting. Along with this portion of the *Principia* we will also examine sections of the *Opticks*, most notably the Queries attached to the end. To further satisfy our quest for an understanding of Newton's metaphysics we will also examine some of Newton's correspondence, portions of previous editions of either the *Principia* or the *Opticks*, and some draft manuscripts for the *Principia* which were never published. It is from this list of material that we will be able to gather the necessary information to justify the thesis. Once again it is difficult to organize the evidence in a simple order, either logical or chronological. It will be presented in a point by point fashion.

(i) *Prisca Sapienta*:

> It was the ancient opinion of not a few, in the earliest ages of philosophy, that the fixed stars stood immovable in the highest parts of the world; that under the fixed stars the planets were carried about the sun; that the earth, as one of the planets, described an annual course about the sun, while by a diurnal motion it was in the meantime revolved about its own axis; and that the sun, as the common fire which served to warm the whole, was fixed in the centre of the universe.
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> This was the philosophy taught of old by *Philolaus, Aristarchus* of *Samos, Plato* in his riper years, and the whole sect of the *Pythagoreans*; and this was the judgment of *Anaximander*, more ancient still; and of that wise king of the *Romans, Numa Pompilius*, who, as a symbol of the figure of the world with the sun in the centre, erected a round temple in honor of *Vesta*, and ordained perpetual fire to be kept in

the middle of it.[59]

In the "General Scholium" to the third book of the *Principia* Newton cites the ancients in support of his theory of universal gravitation. The passage above also suggests that Newton was well acquainted with the teachings of the ancients. Altogether this would suggest that Newton's serious enquiries were not restricted to natural philosophy investigated by an experimental-mathematical method. His studies of theology and ancient chronology were of equal importance to him, and were pursued in as rigorous a fashion as his scientific work. The evidence does not merely derive from his unpublished writings. His published scientific writings show that he did not regard his "avocational" and his "vocational" interests as unrelated. Quite the contrary, he shared the belief, common to the seventeenth century, that natural and divine knowledge could be harmonized and shown to support each other. To reach an understanding of the theological signification of Newton's scientific work we will briefly examine what Newton scholars have called the *Classical Scholia*.

The Classical Scholia were draft scholia to Propositions IV to IX of Book III of the *Principia*. The classical Scholia are so-called due to the fact that Newton discusses the

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[59]Isaac Newton, "The System of the World," in *Sir Isaac Newton's Mathematical Principles of Natural Philosophy and his System of the World*, translated into English by Andrew Motte in 1729, revised by Florian Cajori, 2 volumes (Berkeley: University of California Press, 1971), Vol. II, p.549. Henceforth all passages from the *Principia* or the "System of the World", will be taken from the Motte translation.

anticipation of his doctrines in Graeco-Roman thought of antiquity; actually he also alludes to Egyptian and Phoenician strands in ancient philosophy. Standing alone, these draft scholia contain analogies and parallels so strained that Newton scholarship has, until recently, interpreted them as literary embellishments of the work of a great scientific figure. Rattansi and McGuire[60] have rightly pointed out that the sheer bulk of manuscripts and other writings from Newton's pen make such an interpretation untenable. Added to this is the testimony of Newton's associates along with the publication of some of his other writings, which would seem to indicate that Newton considered the arguments advanced in these scholia to be of importance to his philosophy as a whole.

The circumstantial evidence would seem to support the position that Newton's esoteric preoccupations were not subordinate to his scientific interests. This would then imply, as McGuire and Rattansi have shown, that any direct indication of magical thinking in Newton's scientific writings are to be consistent with the more scientific elements.

> It is now amply clear that Newton's serious enquiries were not restricted to natural philosophy, investigated by an experimental-mathematical method. ... There is sufficient evidence, even in his published writings, to show that he did not regard these different sorts of

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[60]J.E. McGuire and P.M. Rattansi, "Newton and the *Pipes of Pan*", *Notes and Records of the Royal Society of London*, 21 (1966):108-143.

> enquiry as unrelated exercises. Rather, he shared the belief, common in the seventeenth century, that natural and divine knowledge could be harmonized and shown to support each other.[61]

Propositions IV to IX of Book III of the *Principia* have, as their subject-matter, Newton's theory of universal gravitation. He claims in these Propositions that gravity is proportional to the amount of matter in bodies (mass), that gravity is universal to all bodies, and that gravity is inversely proportional to the square of the distance between the centres of the bodies. All these propositions would seem to be susceptible to experimental and mathematical proofs. The question we must ask, then, is why would Newton feel compelled to invoke the authority of the ancients? Would not gravity still remain whether the ancients held it or not? In short, what needs to be asserted to connect the scientific with the use of ancient knowledge as support?

The primary purpose of the Classical Scholia was to support the doctrine of universal gravitation as set out in the Propositions in Book III and to enquire into its nature as a cosmic force. This doctrine is, for Newton, identifiable with the writings of the ancients. The evidence used is not employed in a random fashion, nor is it used for literary and stylistic reasons. Like Newton's method as a whole, the evidence is utilized in a systematic and orderly fashion for the purpose of supporting and **justifying** his theory of matter,

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[61]Ibid, p.108.

space, and gravitation.

From the Classical Scholia we may gather that Newton maintained the belief that the ancients had knowledge equal to, if not superior to, the moderns. We have already mentioned the notion of a *prisca sapienta* or *theologica*. It is within the confines of this belief that Newton wrote the Classical Scholia. He believed that God had once revealed the Scholia and other truths, but they had soon been obscured and only partially rediscovered by certain sages in antiquity. Newton's admission of such a doctrine pinpoints his affinity with the Cambridge Platonists regarding whom we have already spoken.[62]

Newton held the belief that the ancients were well aware of the following four principles: (a) that the structure of matter is atomic and the motion of atoms is through empty space[63]; (b) that the force of gravity acts or operates universally; (c) that the force of gravity can be described to function inversely to the square of the distances between the objects; and (d) that the true cause of gravity is the direct action of God.

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[62]Ibid, p. 132.

[63]Not only does Newton here appeal to the ancients in support of his theory of matter and gravitation, we must also bear in mind that he is also invoking the authority of the ancients against the mechanists. Here Newton was directing his attack on Descartes. The reader should also remember that Descartes fought hard to repeal the authority of the ancients. In this light, it is interesting to note that Newton is using an authority which Descartes explicitly denies.

The task of preparing a second edition of the *Principia* had been entrusted to Fatio de Duillier. In a letter to Huygens, Fatio publicly claims Newton's studies of the *prisca*. The letter is dated the 5th February, 1691/2 and is written in French. McGuire and Rattansi have shown that the letter was sanctioned by Newton. My translation of the letter reads as follows:

> Mr. Newton believes that he has found that all the demonstrations in his System of the World are in accord with the teachings and writings of Pythagoras, Plato, and other Ancients. These demonstrations are founded on Gravity which decreases as the square of the distance increases. And with the divers fragments which we have or can deduce, if placed together, effectively contain the same ideas as those elucidated in the *Principia Philosophiae Mathematica*.[64]

These Propositions are centrally concerned with the doctrine of universal gravitation and its nature as a cosmic force. It will be recalled that Propositions VI and VII are concerned with gravity as a real physical force, accounting for the motion of both perceptible and imperceptible bodies in a non-resisting void. Proposition VI states

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[64]Isaac Newton, *Correspondence*, ed. H.W. Turnbull, Vol.3, p.193. *Monsieur Newton croit avoir decouvert assez clairement que les Anciens comme Pythagore, Platon &c. avoient toutes les demonstrations qu'il donne du veritable Systeme du Monde, et qui sont fondées sur la Pesanteur qui diminue reciproquement comme les quarrez des distances augmentent. Ils faisoient dit il un grand mystere de leurs connoissances. Mais ils nois reste divers fragmens, pa où il paroit, à ce quil pretend, si on les met ensemble, qu'effectivement ils avoient les mêmes idées qui sont repandues dans les Principia Philosophiae Mathematica.*

> That all bodies gravitate towards every planet; and that the weights of bodies towards any one planet, at equal distances from the centre of the planet, are proportional to the quantities of matter which they severally contain.[65]

Newton relates how he experimented with different substances of equal weight to verify this theorem. He alludes to others, perhaps Galileo, having shown that all sorts of heavy objects descend from equal heights in equal times, allowing for atmospheric drag. To the contemporary reader it would be difficult to think otherwise. Newton, however, in the Scholium to this Proposition, claims that this conception of gravity has been with humanity since antiquity. The Scholium is written with a long quotation from Lucretius. In the commentary Newton claims:

> Even the ancients were aware that all bodies which are round the Earth, air and fire as well as the rest, have gravity towards the Earth, and that their gravity is proportional to the quantity of the matter of which they consist. Lucretius thus argues in proof of the void.[66]

Newton held that Lucretius thought, in the manner of the *Principia*, that all matter whatsoever gravitates in a non-resisting void. Implicit in this Proposition is the "atomic hypothesis." As is well known, Lucretius in *De Rerum Natura* makes explicit the atomic hypothesis. After quoting some sixty-two lines from Lucretius Newton turns to the historical

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[65]Newton, *Principia*, Vol. II, Book III, p.411.

[66]McGuire and Rattansi, "Newton and the *Pipes of Pan*", p.112.

succession of the atomic hypothesis.

> This Lucretius taught from the mind of Epicurus, Epicurus from the mind of the more ancient Democritus.[67]

And carrying on the succession Newton alludes to the 'Italic and Ionic' philosophers.

> Among the philosophers who have held that bodies are composed of atoms, it was a received opinion that gravity accrues both to atoms and to composite bodies, and that in individual bodies it is proportional to the quantity of matter. That bodies are compound of atoms was the view of both Ionic and Italic philosophers. *The followers of Thales and Pythagoras,* as Plutarch observes, *deny that the section of those bodies which are subject to movement proceeds to infinity but ceases at those things which are individual and are called atoms.*[68]

Newton, throughout, appeals to the authority of the ancients. The interesting connexion comes in the consideration of the inverse-square law of gravity. It may be argued that the ancients may have postulated atoms and gravity, but they surely did not have any means of knowing the inverse-square law.

It may be difficult for the modern reader to imagine Newton being serious about the anticipation of his views by the ancients. And if it were not for the testimony of men like Fatio and other testimonial portraits of Newton being serious about such matters, one would probably think that

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[67]Ibid, p.113.

[68]Ibid, p.113.

these Classical Scholia merely add a classical bent to a scientific treatise. The Scholium to Proposition VII does not lend itself to such an interpretation. Newton unequivocally claims that Pythagoras discovered the inverse-square law by experimenting with the vibrations of strings. Pythagoras further extended the relation to the weights and distances of the planets from the sun. This true knowledge, expressed esoterically, was lost through the misunderstanding of later generations.

> And, in general terms, if two strings equal in thickness are stretched by weights appended, these strings will be in unison when the weights are reciprocally as the squares of the lengths of the strings. Now this argument is subtle, yet became known to the ancients. For Pythagoras, as Macrobius avows, stretched the intestines of sheep or the sinews of oxen by attaching various weights, and from this learned the ratio of the celestial harmony. Therefore, by means of such experiments he ascertained that the weights by which all tones on equal strings ... were reciprocally as the squares of the lengths of the string by which the musical instrument emits the same tones. But the proportion discovered by these experiments, on the evidence of Macrobius, he applied to the heavens and consequently by comparing those weights with the weights of the Planets and the lengths of the strings with the distances of the Planets, he understood by means of the harmony of the heavens that the weights of the Planets towards the Sun were reciprocally as the squares of their distances from the Sun.
>
> But the Philosophers loved so to mitigate their mystical discourses that in the presence of the vulgar they foolishly propounded vulgar matters for the sake of ridicule, and hid the truth beneath dis-

> courses of this kind. In this sense Pythagoras numbered his musical tones ... . But he taught that the sounds were emitted by the motion and attraction of the solid srheres, as though a greater sphere emit a heavier tone as happens when iron ers a smitten. And from this, it was born the Ptolemaic system ot d orbs, when meanwhile Pythagoras th parables of this sort was hiding his own system and the true harmony of the heavens.[69]

It is interesting to note that the wrong, Ptolemaic, view of the cosmos arose out of a misunderstanding of true knowledge obtained by the ancients. Newton not only held the Copernican view; he claims that its contrary is based on a misunderstanding because the author was not familiar with the esoteric language, and Newton obviously is. The preceding passage is an instance of a fully developed *prisca sapienta*. It does not seem to serve as a literary tool; Newton was quite serious about its contents.

We have thus far seen Newton's reliance on an ancient wisdom. Before continuing it would be well to discuss two related points. Betty Jo Teeter Dobbs has shown that the doctrine of the *prisca sapienta* is explicit in the works of the Cambridge Platonists. McGuire and Rattansi further show that it was through this doctrine that Newton and these Cambridge men were engaged in a dialogue whose terms were set by a certain intellectual tradition. Both Henry More and Isaac Barrow held the doctrine of *prisca sapienta* and we have

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[69]Ibid, p. 116.

already seen their influence upon Newton's career. In this Scholia we see the fruits of this influence. To end this brief section the same theme is picked up in a draft variant to Query 23 of the Latin edition of the 1706 *Opticks:*

> By what means do bodies act on one another at a distance? The ancient Philosophers who held Atoms and Vacuum attributed gravity to atoms without telling us the means unless in figures: as by calling God Harmony representing him & matter by the God Pan and his Pipe, or by calling the Sun the prison of Jupiter because he keeps the planets in their orbs. Whence it seems to have been an ancient opinion that matter depends upon a Deity for its laws of motion as well as for its existence.[70]

(ii) *Gravity, Mechanism, and God:*

The above passage serves as a useful bridge to grasp Newton's understanding of the cause of gravity. It will be noticed that Newton states that for the ancients the cause of gravity is God. If this thesis is to be maintained, it would appear that given the seriousness with which Newton treated the teachings of the ancients, he would be compelled to hold the same view. Before developing this topic we will first look at the mechanism Newton faced in his day.

Descartes' conception of the physical world commits him to the claim that scientific explanations are mechanical, with final causation totally excluded; and that mathematical physics emerges as fundamental natural philosophy. Matter is, for Descartes, a pure idea of reason. This is shown in the

[70]Ibid, p.118.

second meditation wherein he reflects upon a melting piece of wax. The moral of the story was that even though the sensible qualities of the piece of wax underwent change, we can still identify it as a piece of wax. Descartes is here drawing attention to an intellectual conception of matter latent in the mind. It is only later in the *Meditations* that we are informed that the essential property of matter is that it is extended.

Through his method of systematic doubt Descartes has much to reveal about the nature of physical matter. Although most importance is usually accorded to his method of doubt and his *cogito*, Descartes cannot be dismissed in the history of science. His mind-body dualism seems to have touched Newton in a profound way. Descartes' *Principia philosophiae* was a seminal work for Newton; so much so that many take the latter's landmark work, *Philosophiae naturalis principia mathematica*, to be an improvement upon Descartes' work of a similar title.[71] Yet it would seem, as will be shown later, that Newton opposed Descartes on almost every issue pertaining to natural philosophy. In this light it would be absurd to deny Descartes a strong influence upon Newton. In this section we will briefly sketch Descartes' theory of matter and physical science.

Descartes was concerned chiefly with the problem of

[71]I. Bernard Cohen, *The Birth of a New Physics*. (New York: W.W. Norton & Company, 1985), page 211.

intellectual certainty. He therefore set out to construct a system of knowledge based on the powers of human reason alone. Being a mathematician, Descartes was able to incorporate many of his "experiences" into his philosophy. For example, one can readily see that mathematical reasoning often allows one to progress from what one already knows to that which one does not already know. Descartes thought that the various sciences are merely different ways in which one all-embracing method is used. This method is, of course, heavily dependent on Descartes' understanding of intuition and deduction.

Intuition is, for Descartes, an intellectual activity or vision of such clarity that it leaves no doubt in the mind. It is by intuition that we grasp the connexion between one truth and another. For example, it is by intuition that we grasp that if A=B and B=C, then it must necessarily be the case that A=C. For he claims:

> By intuition I understand, not the fluctuating testimony of the senses, nor the misleading judgment that proceeds from the blundering constructions of imagination, but the conception which an unclouded and attentive mind gives us so readily and distinctly that we are wholly freed from doubts about that which we understand. Or, what comes to the same thing, intuition is the undoubting conception of an unclouded and attentive mind and springs from the light of reason alone; it is more certain than deduction itself in that it is simpler, though

> deduction cannot be as erroneously conducted.[72]

Deduction, then, is similar to intuition in that both involve truth. By intuition we grasp a simple truth completely and immediately, whereas by deduction we arrive at truth by a process. The task for Descartes was to rest knowledge on a starting point that had absolute certainty (he talks about an unclouded and attentive mind free from doubt) in the individual's own mind.

In the *Discourse on Method* (1637) Descartes outlines four precepts sufficient for finding his starting point. The first is that one should never accept anything that can be doubted. Secondly, as a matter of heuristics one should divide each difficulty into "sub-tasks". Thirdly, the mind should proceed in an orderly fashion, starting with that which is the simplest to grasp and moving on to the more difficult. And fourthly, the path of the inquiring mind should be one where no stone is left unturned. For Descartes the problem was: What is real and what is illusory? What is true and what is false, or can at least be doubted? What is the simple truth upon which knowledge can rest? Using the example of geometry, he claims:

> Those long chains of perfectly simple and easy reasonings by means of which geometers are accustomed to carry out their most difficult demonstrations had led me

[72]René Descartes, *Discourse on Method*, quoted in A.R. Hall , *From Galileo to Newton*. (New York: Dover Publications, 1981), page 114.

> to fancy that everything that can fall under human knowledge forms a similar sequence; and that so long as we avoid accepting as true what is not so, and always preserve the right order for deduction of one thing from another, there can be nothing too remote to be reached in the end, or too well hidden to be discovered.[73]

Given his own four primary precepts of reasoning and combining his doubt with order, it took Descartes a mere two to three months to unravel some of the more complex problems in geometry and algebra and he writes [I]:

> was also in the end apparently able to determine by what means, and to what extent, a solution was possible, even in the fields where I was still ignorant of one. To this end, I began with the simplest and most general problems; and every truth I discovered was a rule applicable towards further discoveries.[74]

Descartes' reliance on geometry becomes quite evident in these passages ending Part II of the *Discourse*. Knowledge is construed as an organic whole for Descartes. This doctrine of a single, all-embracing method, is contrary to that of Aristotle and the scholastics who preceded Descartes and for whom the different fields of human knowledge all have their own subject matter and appropriate method. Since his method was not bound up with any subject matter, Descartes went on to apply it to the problems of other sciences as usefully as he

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[73]René Descartes, *Discourse on Method* in *Descartes Philosophical Writings*, trans. and ed. by Elizabeth Anscombe and Peter Thomas Geach (Indianapolis: Bobbs-Merrill, 1971), page 21.

[74]ibid, page 22.

had applied it to algebra.[75] Thus Descartes contemplated the possibility and even the necessity that all natural science should be held together by a single logical framework.

Descartes conceded that the principles of other sciences derived from philosophy. The problem is that philosophy itself had no certain, first principles.

> But observing that the principles of those sciences must all be derived from philosophy, in which so far I could discover nothing certain, I thought my first task must be to establish such certainty.[76]

Thus the task is set for Descartes. And since geometry does not start with empirical measurements of lines and angles Descartes thought that science too should draw its first principles from reason. This further underlines the importance for establishing first principles in philosophy. The second floor of a house can be built on a solid first floor; but if there is a poor foundation all will come tumbling down. It is curious, however, that if science is to be built on reason then some interesting parallels arise. For instance, the proof of the impossibility of a vacuum in space is as transparent or evident as that the number of primes is indefinite.[77] Furthermore, that matter is essentially extended is

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[75]Ibid, page 23.

[76]Ibid, page 23.

[77]Descartes reserved the term "infinite" for God alone. Thus, what we normally construe as infinite in mathematics is, for Descartes, indefinite.

as sure and indubitable as Euclid's definition of a straight line.

Keeping in mind the rational method employed in geometry Descartes was able to realize the dictum necessary for a unifying logic for science. That is, he says,

> I judged that I could take it as a general rule that whatever we conceive very clearly and very distinctly is true; only there is some difficulty in discerning what conceptions really are distinct.[78]

Descartes explains how this conviction imposed itself on him from the consciousness of his own existence. In his search for a clear and distinct proposition he came upon the famous *cogito ergo sum*. Of his existence he could not doubt. The criterion for truth, all truth, even in science, is that whatever is true must be conceived clearly and distinctly -- that is, whatever is indubitable is clear and distinct. In general, then, there is no greater guarantee of the truth of a proposition than that, even when bombarded with the rational powers at his command, the proposition still shone clearly and distinctly. To be clear a proposition has to be present and apparent to the attentive mind. To be distinct is to be precise and different from all other objects apparent to the mind.

But how do we guarantee the truth of clearness and distinctness? God is the ultimate guarantor for the distinction between mere appearance, or falsity, and reality, or

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[78]Ibid, page 32.

truth. All this points to an *a priori* stance with respect to science. Descartes was, however, willing to admit the difficulties of his method. Even though the general rule is the principle of clearness and distinctness, we must keep in mind that "only there is some difficulty in discerning what conceptions really are distinct." But nonetheless, his emphasis remains on the use of reason and not the senses. Concluding Part IV of the *Discourse* he claims:

> For, in conclusion, waking or sleeping, we should never let ourselves be convinced except by the evidence of our reason. Note that I say our reason, not our imagination or our senses.[79]

Descartes essentially saw the structure of all knowledge, and especially science, as theoretical. Any dissident from this logical continuity must be false.

By setting the stage that truth must be derived through reason, either from previous clear and distinct ideas or must itself be evidently clear and distinct, the implications derived by Descartes for his system of nature came under severe attack. Most notably was this true of the system of nature found in his *Principles of Philosophy* (1644) published two years after the birth of Newton.[80] However, his insist-

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[79]Ibid, page 37.

[80]A.R. Hall in his *From Galileo to Newton*, pp. 114-115, claims that the reasons for the vulnerability of this work were twofold. Firstly, Descartes' insistence on the strengths of intuition often led him to blundering, imaginative constructions. Secondly, the weakness of the Cartesian system of nature was "its shadowy relevance to experience." A particle of matter could just not be thought or reasoned into exist-

ence on reason and clarity did offer a point of stability. He did maintain that the mind could attain universal truths and justifiably have faith in them. This no doubt had an influence on Newton. Nonetheless, Newton saw a grand scheme in which Descartes' system was not tolerated.

The universe of Descartes is one in which everything is in motion. Viewed as a whole, however, the universe operates on a grand conservation principle: the quantity of motion and matter in the universe remains constant. In viewing it as a whole, the universe would appear static. If matter and motion remain constant as a whole in the indefinite universe, the possibilities of local variation are endless. Descartes made only one distinction between matter and the space it fills: the former is movable. For Descartes, matter is everywhere. And what is the essential characteristic of matter? I have already mentioned it in passing; it is extension.

> The nature of matter, or of body considered in general, does not consist in its being a thing that has hardness or weight, or colour, or any other sensible property, but simply in its being a thing that has extension in length, breadth, and depth.[81]

Matter, then, for Descartes fills all space. Since by space we mean nothing but length, breadth, and width, there

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ence; there must be some empirical basis for its characteristics.

[81]René Descartes, *Principles of Philosophy* in *Descartes Philosophical Writings*, trans. and ed. Elizabeth Anscombe and Peter Thomas Geach (Indianapolis: Bobbs-Merrill, 1971), page 199.

cannot be any vacuum. We say that this or that object occupies some space. This claim amounts to saying that length, breadth, and depth are attributable to space. And since these characteristics mean nothing but extension, it follows that space must be extended. If space is extended, so the argument goes, space must be material.

> The impossibility of a vacuum in the philosophical sense -- a place in which there is absolutely no substance -- is obvious from the fact that the extension of a space or intrinsic place is in no way different from the extension of a body. For the extension of a body in length, breadth, and depth justifies us in concluding that it is a substance, since it is wholly contradictory that there should be extension that is the extension of nothing; and we must draw the same conclusion about the supposedly empty space -- viz. that since there is extension there, there must necessarily be substance as well.[82]

Matter fills all space, but only its grosser manifestations are directly perceivable by humans. That is, matter exists in three species: matter, aetherial substance, and material light. It is the latter which is plastic enough to fill the gaps left between the particles of matter and aether so that no space is left void. Interestingly, however, Descartes has often been credited, along with Hobbes, with the revival of the corpuscularian thesis. He is, though, an ambiguous corpuscularian. For Descartes, there are but two types of substances: spiritual (*res cogitans*) and corporeal (*res*

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[82]Ibid, page 205.

extensa). The corporeal substance is extended. Matter, it must be recalled, is composed of particles none of which is indivisible. In other words, Descartes' corpuscles have the characteristic of being indefinitely divisible. This is simply because if indivisible atoms did exist they must be extended. It would be a contradiction, says Descartes, for the mind to think of something which is extended yet indivisible. If it is extended we could divide it into something smaller which is itself extended, and so on.

We have already hinted at Descartes' grand conservation scheme. Implied is both a conservation of matter and of motion. Since the nature of matter is that it occupies all space, the motion of particles must simply be a displacement or rearrangement of matter. This must involve the continuous impact of particle upon particle. Under such conditions, the continuous impact of one body on another, any movement tends to create a swirl or vortex.

Descartes was a believer in the Copernican system and felt that he could account for it. His system of nature was flexible enough to account for the movement of the heavenly spheres, and also account for the troublesome notion of force at a distance. Quite simply the solar system is nothing but an aetherial vortex in which the sun is at the centre and the planets whirled around it in the aether.[83] Some of these

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[83]I have been told by Professor W. Harper that Huygens experimented with this notion. Huygens claims to have proven the vortical thesis in an experiment in which he placed two

planets, such as the earth, are also centres of smaller vortices in which satellites such as the moon are in motion around it. This type of motion is much akin to the motion of a leaf caught in a whirlwind.

Descartes' system has been the source of much scholarship over the years, and I do not wish to contribute to that particular debate at this moment. Suffice it to say that Descartes' mind-body dualism posed some serious problems in the intellectual climate of that time. Many questions arose with respect to this "non-intuitive" scheme which he developed. It is precisely for this reason that we are even considering Descartes in a thesis on Newton, and to this topic we now turn.

The discussions between Henry More and René Descartes have an important place in Newton scholarship. As we shall see, Newton inherited not only the desire for alchemical research from More, but he also inherited some compelling arguments against Descartes.[84]

Newton saw a limitation in this mechanical explanation of gravity and its effects. His reasoning went something like the following. In Book I, Section II, Proposition I of the

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parallel strings across the diameter of a large shallow dish filled with water. At one end of the string he placed a ball. By spinning the dish Huygens was able to make the ball travel to the centre of the dish and thus confirming the theory.

[84]For a discussion of the debate between Henry More and Descartes refer to Alexandre Koyré's *From a Closed World to the Infinite Universe*.

Principia Newton was able to demonstrate mathematically the determination of centripetal forces. His proof is geometric. He did not use his method of fluxions and, consequently, this proof as well as the entire *Principia* is quite tedious. We will not go into the details of the proof here but, suffice it to say that, he was able through the construct of reason to determine what has been called the Area law. Simply put, this law states that a revolving body of a given radius to an immovable centre of force will describe an area proportional to the time required. Kepler developed the same law through observation, using data obtained from Tycho Brahe. Kepler's Area law was based on observation; Newton developed his through reasoning. What surprised Newton, however, was the precise corroboration between his findings and Kepler's; that is, his general area law of bodies revolving about a centre of force matched Kepler's observed area law precisely.

One would expect Newton to view such a situation with happiness. It should be remembered that we are not arguing the claim that Newton was <u>not</u> a mechanist; I am merely claiming that his form of mechanism was ambiguous. He certainly accepted the theory that matter is formed of atoms. He differed, however, from the mechanists on the interaction between matter and "non-matter." On good mechanistic grounds, even with a postulated aether, there should be a deviation between the mathematical description and prediction of the general area law and the observed occurrence and prediction of

Kepler's law. This did not happen! By analogy, one can readily observe a deviation between the mathematical prediction and the observed results of projectiles on earth. Likewise, the planets should, when observed, deviate somewhat from Newton's mathematical prediction.

The mechanical aether must pose some resistance to planetary bodies. Descartes' position that matter is everywhere could not account for this precise match. It is here that Newton breaks from the mechanism of his day by rejecting its most basic assumption. For Descartes, the only way to account for force is by postulating the impact of one body on another. Force at a distance; that is, gravity, operates through a voidless aetherial medium. It is an interesting trick: what appears as two unattached bodies are in physical reality attached. To Newton this was incomprehensible. He rejects the Cartesian position on both scientific and theological grounds.

The grounds on which Newton rejects the Cartesian philosophy of nature, both scientific and theological, are meshed together. One supports the other. In the end, however, Newton held that irrespective of which theory one employs to explain the workings of nature one is always dependent on God's workmanship. In other words, although the scientific and theological reasons Newton adopts are taken together, clearly it is the theological reasons which have priority.

> When I wrote my treatise about our system, I had an eye upon such principles as might work with considering men for the belief of a Deity; and nothing can rejoice me more than to find it useful for that purpose.[85]

Following the lead of the Cambridge Platonists, Newton essentially charges Descartes with atheism. The Cartesian God, according to Newton, is nothing but an absentee landlord. That is, God created the world and then stood back and watched it operate. The absentee landlord is like a watchmaker who, after fabricating the finished product, winds it up and lets it tick. For Newton, however, this state of affairs seemed to contradict the very fibre of faith. By relegating God to the position of an absentee landlord Descartes has not strengthened faith, but rather has taken a step closer to atheism. An all-powerful, omniscient, and omnipresent God could not just stand idly by as creation ticked away. This is contrary to the Creator. Rather, Newton believed God to have a "dominion" over creation. God's muscle is exercised from time to time.

> The Supreme God is a Being eternal, infinite, absolutely perfect; but a Being, however perfect, without dominion, cannot be said to be Lord God; ... It is the dominion of a spiritual being which constitutes a God: a true, supreme, or imaginary dominion makes a true, supreme, or imaginary God.[86]

But it is not enough only to suggest a dominion if God were to

[85]Letter to Richard Bentley, 10 December, 1692, in *Newton's Philosophy of Nature: Selections from his Writings*, ed. H.S. Thayer (New York: Hafner Press, 1974), p.46.

[86]Newton, *Principia*, p.545.

exist; God does exist. The dominion of God is a true and real dominion.

> And from his true dominion it follows that the true God is a living, intelligent, and powerful Being; and from his other perfections, that he is supreme, or most perfect. ... He is omnipresent not *virtually* only, but also *substantially*; for virtue cannot subsist without substance. In him are all things contained and moved; yet neither affects the other: God suffers nothing from the motion of bodies; bodies find no resistance from the omnipresence of God.[87]

It is the last sentence of this passage which we find intriguing. God is everywhere and in God everything is contained, yet there is no interference in the motion of bodies. God, and not an absentee landlord, could only affect motion if a spiritual substance can somehow interact with corporeal substances. The lack of discrepancy between Kepler's observed laws and Newton's mathematical principles can only be accounted for by postulating a void. Descartes could not accept a void into his principles because his definition of matter forbade it. If matter's prime quality is that it is extended, then it follows that everything is either extended or is not matter. If it is extended, then it is matter, if it is not extended then it is spiritual. For

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[87]Newton, *Principia*, p.545. It is also interesting to note that there is a marginal note to this passage in the *Principia*. The marginal note cites some of the main sources of the "System of the World" and the "Classical Scholia." These sources include, among others, Pythagoras, Cicero, Thales, other ancient Greek philosophers, and various books of the Bible. Once again this can be taken to be proof of Newton's loyalty to the *prisca sapienta*.

Descartes, then, to distinguish between matter and spirit one must merely distinguish extension from non-extension. This, Newton thought, not only relegates God to an absentee landlord, it is a precarious thesis in that God cannot act or be in this universe. For how could a non-extended substance interact with an extended substance to cause motion at the beginning of the universe? In other words, Newton saw a problem with the Cartesian system in that it could not account for how everything was placed in motion.

And it would not do to ascribe gravity as inherent in or innate to matter. If the Cartesians, and hence the mechanists, ascribed gravity as essential to matter they would still be left with an absentee landlord for God. This is evidenced again from Newton's correspondence with Richard Bentley.

> So, then, gravity may put the planets into motion, but without the divine power it could never put them into such a circulating motion as they have about the sun; and therefore, for this as well as other reasons, I am compelled to ascribe the frame of this system to an intelligent Agent. ... You sometimes speak of gravity as essential and inherent to matter. Pray do not ascribe that notion to me ... .[88]

And we have already seen that Newton, in the Classical Scholia, maintained that God is the source of gravity. Gravity, is the vehicle by which God can act upon the world.

> For in God's house (which is the univer-

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[88]*Newton's Philosophy of Nature*, p.53.

> se) are many mansions, and he governs them by agents which can pass through the heavens from one mansion to another.[89]

Space then is God's sensorium, if we can call it that. Concluding the *Opticks* Newton reiterates the analogy quoted above in more specific terms. Here, however, it is God's will which governs the universe. This will can change the parts of the sensorium with greater ease than we can move parts of our bodies.

> Such a wonderful Uniformity in the Planetary System must be allowed the Effect of Choice. And so must the Uniformity in the Bodies of Animals, ...; and the Instinct of Brutes and Insects, can be the effect of nothing else than the Wisdom and Skill of a powerful and ever-living Agent, who being in all Places, is more able by his Will to move the Bodies within his boundless uniform Sensorium, and thereby to form and reform the Parts of the Universe, than we are by our Will to move the Parts of our own Bodies.[90]

Undoubtedly, then, Newton's God is an active God. He is obviously borrowing Henry More's contention that Descartes' bifurcation of substances into extended matter and non-extended spirit or mind is fundamentally mistaken.[91] In order for God to effect change in the physical world one must allow for extension to be ascribed to spiritual substance.

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[89]*Newton's Philosophy of Nature*, manuscript quoted by David Brewster, p.67.

[90]Newton, *Opticks*, p.402.

[91]See Alexandre Koyré, *From a Closed World to an Infinite Universe* (Baltimore: The John Hopkins Press, 1957) for a discussion of the More-Descartes debate.

From this discussion we can now turn to two related points: (a) the place for God in science and (b) the penetrating force of spirit. We will begin with the latter.

(iii) *The Penetrating Force of Spirit*:

It is important not to misrepresent Newton on the subject of mechanism. At first, Newton was very much attracted by the Cartesian philosophy with its accompanying mechanism. He soon recognized deficiencies in this philosophy. How he arrived at it we have already discussed. In reviewing Kepler's area law Newton deduced that since there were no discrepancies between his mathematical model and Kepler's observations it would appear that gravity seems to act to the centres of bodies. One could almost discard whatever the body may be and treat it as a point source. Hence bodies, in Newton's grand scheme of things, are represented as mathematical points. Gravity seems to penetrate straight through to the centres of bodies. To account for this Newton entertained many hypotheses among which we find an altered mechanism.

Newton's altered mechanism comes to life in his theory of matter. We must bear in mind that Newton was a second generation spectator of mechanism. He was immersed almost from the beginning in this school of thought and, ironically, it was this school which formed a backdrop against which his alchemy was played out.

> He was in short a mechanical philosopher in his own right, although perhaps not yet full fledged, for some years before he became an alchemist, and there is no

> reason whatsoever to suppose that *alchimia*, for all her charms, ever fully supplanted *philosophia mechanica* in his affections.[92]

His final formulations on the nature of matter grew naturally out of his obsession with alchemical, theological, metaphysical, and observational concerns. In short, Newton was an eclectic thinker, borrowing from what may appear contradictory modes of thought to formulate his views regarding the nature of matter and the powers connected therein. Newton's formulations regarding his theory of matter can be divided into three different theses corresponding roughly to three distinct times in his life. In his student years Newton adhered to a mechanist thesis of corpuscles. During this time he postulated a mechanical aether. For reasons soon to be discussed he abandoned this thesis for an interim position of force. This force he called vital spirit. The aether was still maintained, however in a spiritual guise. In the end, however, he deserted this position for the more theological position of spirit. To these three positions we now turn.

During his student years Newton was an eclectic corpuscularian. He borrowed from the works of Descartes, Hobbes, Boyle, Gassendi, Digby, and More, the latter eventually abandoned the corpuscularian thesis. Newton postulated a mechanical aether by which he could explain force at a

[92]B.J.T. Dobbs, *The Foundations of Newton's Alchemy or "The Hunting of the Greene Lyon"* (Cambridge: Cambridge University Press, 1975), p.197.

distance (gravity) and the cohesion of particles. The latter explanandum has always been a stickler for atomists, even in antiquity. How matter, with all its particles, "stuck" together always puzzled the strict mechanists.

Ultimately however, Newton's notion of the cohesion of matter derives from his alchemical studies where it is postulated "all species are from one root." Both alchemy and mechanical philosophy share the common notion of the ultimate unity of matter. One would be hard pressed to locate within the mechanical counterpart the active, vitalistic agent which Newton introduced around 1669 in what has come to be called his "Propositions."[93] Apparently Newton called the vitalistic agent "magnesia" -- obviously a code term which kindled in the alchemist the mystical qualities of a magnet and "expressed their understanding that certain substances had the capacity to draw into themselves the active vivifying celestial principle necessary for life."[94] Later in the *Opticks* magnesia became the "fermental virtue" or the "vegetable spirit" which was the force of fermentation.

> This and only this is the vital agent diffused through all things that exist in the world.
> And it is the mercurial spirit, most subtle and wholly volatile, dispersed through all places.

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[93]B.J.T. Dobbs, "Newton's Alchemy and his Theory of Matter," *Isis* 73 (1982):511-528. On page 514 Dobbs is referring to the "Propositions" of 1669 contained in Keynes MS 12A, fol. 1v. in the Portsmouth Collection.

[94]Ibid, p.514.

> This agent has the same general method of operating in all things, namely, excited to action by a moderate heat, it is put to flight by a great one, and once an aggregate had been formed, the agent's first action is to putrefy the aggregate and confound it into chaos. Then it proceeds to generation.[95]

The source of Newton's vital agent must be alchemy. He was however to get reinforcement from other sources later on.

He began by being concerned with life and cohesion; he now sought the source of all apparently spontaneous processes of fermentation, putrefaction, generation, and vegetation. Mechanical processes could not account for the sheer variety of forms in the world, all of which had somehow descended from a common matter. On mechanical grounds, the sheer variety of forms in nature could only arise by chance. To account for this variety Newton introduces a vital aether which is described in a long and untitled alchemical treatise. Newton scholars usually refer to this treatise by its inaugural sentence: "Of nature's obvious laws and processes in vegetation."[96] In this treatise Newton likens the earth to a great animal which takes in long breaths, of course it is the vital aether which is inhaled. He calls this aether a subtle spirit, the "material soul of all matter."[97] Thus, in the

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[95]Keynes MS 12A, fol. 1v. Quoted in Dobbs, "Newton's Alchemy", p.515.

[96]Dobbs, "Newton's Alchemy," p.515.

[97]An ensuing thesis defended by Dobbs ("Newton's Alchemy", "Newton's Alchemy and His 'Active Principle' of Gravitation" in *Newton's Scientific and Philosophical Legacy*, ed. Scheurer

beginning at least, Newton attempted to adhere to a mechanistic account of gravity and matter in the form of a subtle, yet material, aether.

It is important to bear in mind that Newton's contemporaries among the Cambridge platonists were alarmed at the atheistic potentialities in the revived corpuscularianism. Even the ancient atomists, although far from being atheists, were repeatedly branded atheists because their atoms in random mechanical motion received no guidance from the gods. Descartes and the new mechanists believed they had solved this problem by simply stating that God had endowed the particles with motion at the moment of creation. The mechanists thought that the mechanical philosophy was safe from the accusations of heresy. Furthermore, it was held that a "christian" mechanism supported the argument from design; that is, teleologically speaking, we could not have the beautiful plants and flowers without God's involvement. A theological difficulty arose, especially for the Cartesians, with respect to the account of how divine providence operated in a law-bound universe emerging from the new science. The difficulty was most pronounced among the Cartesians because for them the

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and Debrock (Hingham, Ma.: Kluwer, 1988)) and Rattansi and McGuire ("Newton and the 'Pipes of Pan'") is that this vital matter which is "breathed in" is actually a Stoic conception. Dobbs, especially, traces the Stoic connexions in Newton's thought. The vital aether, or active principle, is paralleled by the Stoic *pneuma*. It is further maintained that alchemy and the alchemists contributed greatly to the maintenance of Stoic thought into the seventeenth century.

only acceptable scientific explanations involved the theoretical notions of matter and motion. Henry More, as we have seen, supported Descartes' position at first, but later relinquished his support on the grounds that the Cartesian mechanism leads one to atheism. Descartes' God set matter in motion in the beginning, but had no way of exercising providential care.

Newton faced this theological uncertainty squarely. Newton, as a good theist, maintained that God produced the bountiful diversity in Nature. The vital spirit, or subtle spirit, is the agent by which God exercises providential care among the atoms. It is through alchemy that Newton felt he could come to study and demonstrate God's action in the world by demonstrating the operations of the non-mechanical vegetable spirit.

At first Newton suggests that the vegetable spirit is the aether. But the aether posed its own mechanical deficiencies, and, consequently, he postulated that the aether is actually a vehicle for some more active spirit entangled within it. Newton scholars have associated this speculation with what has come to be known as Newton's hierarchal principles, most likely derived from the neoplatonists at Cambridge. Newton seriously entertained the possibility that this active spirit is the "body of light."

> This spirit perhaps is the body of light because both have a prodigious active principle, both are perpetual workers. 2 Because all things may be made to emit

> light by heat. 3 The same cause (heat) banishes also the active principle. ... Heat is a necessary condition to light and vegetation. (Heat excites light and light excites heat; heat excites the vegetable principle and that increases heat.) No substance so indifferently, subtly, and swiftly pervades all things as light, and no spirit searches bodies so subtly, piercingly, and quickly as the vegetable spirit.[98]

Newton did not remain committed to the notion that the vegetable spirit was the body of light. In a 1674 tract on vegetation he was thinking more in terms of a material agent carried by the aether yet was composed of finer particles and, consequently, more active particles. His various expressions of the aether were always particulate and, in this, he differed from the Stoic *pneuma*.

This conception of the aether being particulate posed a problem for Newton. He realized, probably while composing the *Principia*, that a particulate aether would only serve as drag on the motion of planets and comets. This was the discovery that there existed no deviation between his mathematical construction of the area law of planetary motion and Kepler's observed area law of the same phenomenon. Newton therefore turned away from aetheral mechanisms and toward theories of interparticulate forces that could account for the operations of chemistry and cohesion. In other words, the dismissal of a cosmic aether also led him to reconsider his interstitial

[98]Burnby MS 16, fol. 4r; quoted in Dobbs, "Newton's Alchemy", p.521.

aether as well.

He started to consider seriously the void of ancient atomism. In this he based his argument on some experimental facts:

> 1. Light can be transmitted through pellucid bodies without being lost or stifled;
> 2. Magnetic and gravitational forces could pass through even very dense and opaque bodies without the slightest diminution.[99]

The various parts of matter were held together not by a mechanical aether but rather by interparticulate forces. And thus, Newton's interparticulate pores were not truly void for they contained these forces. In comparing this stance with that of ancient atomism it would appear that all that Newton borrowed from the older school is the limited divisibility of matter. The most basic and primitive particles never wear or break, and thus their permanence guarantees that

> Nature may be lasting, the Changes of corporeal Things are to be placed only in the various Separations and new Associations and Motions of these permanent Particles ... .[100]

With the basic notion of aether discarded, Newton still had to account for the vegetative spirit and whether this spirit is the "body of light." With respect to the latter, Newton continued to think that light at least contributed to the activity of matter -- the difference now lies in the fact

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[99]Newton *Opticks*, p.266-269.

[100]Ibid, p.400.

that he no longer held that light contributed to all the activity, but to much of it; for he claims in the *Opticks*:

> Are not gross Bodies and Light convertible into one another, and may not Bodies receive much of their Activity from the Particles of Light which enter their Composition.[101]

With regards to the first point, Newton skirted the metaphysical problem regarding the corporeality of the vegetative spirit while still offering an explanation for cohesion and vegetation. The question as to whether the vegetable spirit was corporeal or incorporeal remained ambiguous. Theologically, the vegetable spirit could be identified with the light of Genesis. God created light and it is an obvious candidate for the active agent God could call into action to assist in the rest of creation. Newton, and any alchemist, could not subscribe to this limiting notion. They would also point out that the animating vegetable spirit could be identified with the spirit of God moving upon the face of the waters in Genesis. These identifications left the question of the corporeality of the vegetable spirit in a state of ambiguity.

In response to this ambiguity Newton combed the alchemical literature for assistance. The alchemical literature was ripe with information regarding vegetation of metals.[102]

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[101]Newton, *Opticks*, p.374.

[102]Dobbs informs us that Newton opined that "metals are the only part of the mineral kingdom that vegetate..., other mineral substances being formed mechanically." Dobbs, "Newton's Alchemy," p.523. This information was derived from the Burnby MS 16, fol.3r which could not be obtained for

Since the vegetation in animals and vegetables in other kingdoms would be more complex, vegetation in metals is the simplest case for study. In other words, the key to non-mechanical action lay in the vegetation of metals. Dating from the 1670s until the 1690s[103] Newton describes in many papers the living processes he thinks are occurring at the lowest levels of the hierarchies of matter to form metals. In the final manuscript he alludes to the male and female parts of material. The first agent, his vegetable spirit, is the bond between the male and female aspects which enable them to bond to form "the young king," "the more noble offspring."[104] But as we have mentioned, the corporeality of the vegetative spirit is still left in doubt and, consequently Newton had recourse to interparticulate forces which offered an explanation for vegetation and cohesion while not addressing the metaphysical question. Although the metaphysical status of forces remained in doubt, Newton maintained their usefulness in explaining the phenomena of nature -- the interparticulate forces were analogous to the force of gravity.

I have said much about the corpuscularian thesis and mechanism. These were the recurrent tides of informed opinion

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verification. The reader is also encouraged to consult Mircea Eliade, *The Forge and the Crucible* (Chicago: The University of Chicago Press, 1978).

[103]We should recall that the *Principia* was first published in 1687.

[104]Babson MS 420 quoted by Dobbs, *Newton's Alchemy,* p.523.

in the seventeenth century. Newton's contemporaries were accustomed to the idea of action by mechanical impact only, and consequently they found Newton's forces flavourless to say the least. Forces did really exist, though Newton had no way of explaining them. They were physical, though not mechanical, and were measurable by their effects. They were not mechanical in the seventeenth century sense although they were natural, law-bound forces. Although the metaphysical status of the forces remained undecided, Newton held that they, like the analogous force of gravity, were useful in explaining the phenomena of nature.

> The Particles of Acids are ... endued with a great Attractive force; ... And as this Globe of Earth, by the Force of Gravity, attracting Water more strongly than it doth lighter Bodies, causes those lighter Bodies to ascend in the Water, and to go upwards from the Earth: So the Particles of Salts, by attracting the Water, do mutually avoid and recede from one another as far as they can, and so are diffused throughout the whole Water.[105]

And again in the *Opticks* we hear Newton making his most general statement on forces:

> It seems to me farther, that these Particles have not only a *Vis inertiæ*, accompanied with such passive Laws of Motion as naturally result from that Force, but also that they are moved by certain active Principles, such as is that of Gravity, and that which causes Fermenta-

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[105]Isaac Newton, *Some Thoughts about the Nature of Acids*, in *Newton's Papers and Letters on Natural Philosophy*, ed. by I.B. Cohen (Cambridge, Ma.:Harvard University Press, 1978), p. 257.

tion, and the Cohesion of Bodies.[106]

In the General Scholium of the *Principia* Newton calls the interparticulate force "a certain most subtle spirit which pervades and lies hid in all gross bodies."[107]

Having been taught in a new corpuscularian tradition, the concern for the problems of cohesion and activity, for life and vegetation, and for the specific manner in which God exercises providential care seems to have been assuaged by postulating the active forces of cohesion (and consequently repulsion) and fermentation. Fermentation initiates and controls changing relationships among the particles and seems to have been derived from the alchemical "fermental virtue" and "vegetable spirit." The corporeality of such forces remained, however, ambiguous. That "certain most subtle spirit" was "electrical attraction unexcited." It is attraction without friction and only extends to small distances. The electrical spirit was "a most subtle medium and very easily permeates solid bodies."[108] Furthermore, the electric spirit is a "most active" medium that could "emit light", and Newton had come to believe that the electric spirit could be

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[106]Newton, *Opticks*, p.401.

[107]Newton *Principia*, p.547

[108]Isaac Newton, MS.Add. 3965 fols. 361-2 of the Portsmouth Collection, translated by A. Rupert Hall and Marie Boas Hall in *Unpublished Scientific Papers of Isaac Newton. A Selection from the Portsmouth Collection in the University Library, Cambridge* (Cambridge: At the University Press, 1962), p. 362. This MS corresponds to the "Scholium Generale" of the *Principia*.

a true physical manifestation of the vegetable spirit.[109] He was able, through the identification of the vehicle of the vegetable spirit as electrical, to explain cohesion, diversity, continuity of living form, and vegetation.

The ambiguity regarding the corporeality of the spirit remained a nuisance for Newton. We have seen that he began by postulating a material aether. This notion gave way to a more mature concept of force. Finally, he relinquishes this notion for a more theologically sound explanation for matter. For Newton, it was theologically unacceptable to designate the forces which generate activity in nature as intrinsic to matter. Matter is passive; activity, or the generation of activity, in matter belongs to the province of the divine. To attribute activity and the power to generate activity to matter is to attribute to matter an independent reality which belongs only to God. If something is independently real, then divine providence could not affect it. Therefore, to ascribe the power of generating activity and activity itself to brute matter would lead one to atheism.[110]

When Newton talks about active principles we should understand him to mean that a divine spirit is there at work either directly or indirectly.

> And hence it is not surprising that atheists arise ascribing that [independent

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[109]Ibid.

[110]Again we see the polemic against the Cartesians and the mechanists.

> reality] to corporeal substances which solely belongs to the divine. Indeed, however we cast about we find no other reason for atheism than this notion of bodies having as it were a complete, absolute and independent reality in themselves, such as almost all of us, through negligence, are accustomed to have in our minds from childhood (unless I am mistaken), so that it is only verbally that we call bodies created and dependent.[111]

There is no mistaking the severity with which Newton censures the Cartesian teachings regarding matter. Newton, as we have seen, was devoutly religious. In the passage above, he claims that the reason for atheism is the adherence to the notion of the fundamental independent reality of created substances.

The divine spirit, since it must have an independent reality, cannot be corporeal. From this, an interesting argument arises. Since, for Newton, a divine spirit was <u>necessarily</u> at work behind any active force which generated motion, then two possibilities arise:

> 1. If an active force was proven to be incorporeal, its operations would be direct evidence of the operations of the divinity in the universe.
> 2. If, on the other hand, the active force was found to be corporeal, then an incorporeal spirit must stand behind it.

The corporeality of the active force remains ambiguous, however an active God who has dominion over nature and exercises providential care is not relegated to being an "absentee landlord." Behind the universal gravity, as well,

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[111]Newton, *Unpublished Scientific Papers*, p.197.

whether or not its operations were corporeal or incorporeal, stood the omnipresence of God.

> He [God] is omnipresent not *virtually* only, but also *substantially*; for virtue cannot subsist without substance.[112]

And finally, we have already cited passages from the discussions between Newton and Richard Bentley. A recurring theme in Newton's letters to Bentley is the ascription of gravity to matter. Newton often claims that he should not be interpreted as having ascribed innate gravity to matter. From these letters Bentley went on to give the Boyle lectures and aptly entitle them *A Confutation of Atheism from the Origin and Frame of the World* in which he claims he is obliged to the divine theorist Mr. Isaac Newton. For Newton, a discussion of God does belong to natural philosophy. In the General Scholium he claims:

> And thus much concerning God; to discourse of whom from the appearances of things, does certainly belong to Natural Philosophy.[113]

(iv) *Newton and the Concept of Transmutation in his Published Writings:*

I have spoken of Newton's adherence to an ancient line of wisdom, of his ambiguous mechanism and its relation to gravity, and his mature notion of a penetrating force. There

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[112] *Principia*, p.545.

[113] *Principia*, p.546.

is one more piece of direct evidence to offer: there is a sense in which Newton conveyed his thoughts on gravity in his published writings, and most notably in his *Opticks*. Amongst his two great works, the *Principia* and the *Opticks*, it is the latter which enjoyed the greatest popularity after Newton's death.[114] This can be accounted for on the following grounds: (a) unlike the *Principia* which was written in a more formal and mathematical style, the *Opticks* is far simpler to read; (b) the latter appealed more to the experimentally minded in that it contained less of the theory for which the *Principia* was known; (c) the *Opticks* did not require the prerequisite knowledge of advanced mathematics (which, of course, was not common even among the learned) as did the *Principia*.[115] To most intellects of the eighteenth and nineteenth centuries, the *Opticks* was, by far, the more empiricist-minded of Newton's two major works. We are not concerned with whether this or the other book was the more empirical, but rather, we wish to know whether the *Opticks* was tainted with esoteric thinking. The answer, I believe, is in the affirmative. We have already noted sections of the *Opticks* which would support this view. At this point I should

[114]Marjorie Hope Nicolson, *Newton Demands the Muse* (Princeton: Princeton University Press, 1946).

[115]There is an account of how John Locke requested the aid of a mathematician friend in order to move through the first half (Books I and II) of the *Principia* so that he could understand the backdrop to which the more philosophical "System of the World" was written.

like to draw attention to one final remark Newton makes near the end of the work. In Query 31 of the *Opticks* Newton claims the following:

> And thus Nature will be very conformable to her self and very simple, performing all the great Motions of the heavenly Bodies by the Attraction of Gravity which intercedes those Bodies, and almost all the small ones of their Particles by some other attractive and repelling Powers which intercede the Particles.[116]

Just as there is gravity for the macrocosm, there exists yet a parallel active principle for the microcosm. We have seen that for Newton this turned out to be the force of fermentation, the vegetable spirit. The parallel here is striking. Historians of science have often cited, in the works of the alchemists, the similarities that exist between the macrocosm and the microcosm.

> While we always point to a special interest in the study of matter and its changes -- especially transmutation -- there are other themes which also recur frequently. One of these is the deep-seated belief that alchemy had a special role to play in medicine ... . No less important was the persistent conviction that alchemical study was fundamental for a true understanding of nature because of its reliance on observation and experience rather than logic and argument. The alchemist believed in a unified nature, and he expresses this belief most frequently through the macrocosm-microcosm analogy. There was little doubt in his mind that man's direct connection with the greater world would permit him -- through its study --to reach a more pro-

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[116]Newton, *Opticks*, p.397.

> found knowledge of the Creator.[117]

And for Newton the macrocosm-microcosm analogy was foremost in his mind. Just as the alchemist believed in a unified nature, Newton always maintained that "Nature is very consonant and conformable to herself."[118]

Nature is filled with many wonders. No less important was all the activity which abounds in nature. It is probably this which prompted the mechanists to formulate the theories which they did. To Newton, these theories were incorrect. Nature, he claimed, works quite well. Nature is filled with many wonders and it should not be mistakenly thought that they arose out of chaos. To the average person, nature seems to be filled with many changes and Newton wants to reassure us that these strengthen the teleological purpose of nature. The discovery of the riddle that underlies these changes leads one to God. The discovery of the workings of nature were described by Newton in the following way:

> The changing of Bodies into Light, and Light into Bodies, is very conformable to the Course of Nature, which seems delighted with Transmutations.[119]

As Mircea Eliade has claimed, Newton sought in alchemy the structure of the microcosm to match the larger cosmological

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[117]Allen G. Debus, *The Chemical Philosophy, Paracelsian Science and Medicine in the Sixteenth and Seventeenth Centuries. 2 Volumes*. (New York: Science History Publications, 1977), Vol. I, p. 314.

[118]*Opticks*, p. 376.

[119]*Opticks*, p.374.

system.[120]

In order for Nature to be very consonant and conformable to herself, to be delighted with transmutations, it must have been endowed with the necessary "ingredients" to be such by an intelligent Agent. We have already seen that Newton's theism required his God to be actively involved in all of the Deity's work. In the unravelling of the riddles of Nature, the laws of nature as we have come to call them, Newton was an artist who could draw the way God functioned in the universe. He claims:

> For it became him who created them [the solid Particles of matter] to set them in order. And if he did so, it's unphilosophical to seek any other Origin of the World, or to pretend that it may arise out of Chaos by the mere Laws of Nature.[121]

God, then, is the most general cause in the universe, discourse of whom must be admitted to natural philosophy. Newton's method of experiment, observation, and induction, as we have previously seen, compels him to discourse of God. Contrary to early twentieth century empiricism which, as a school of thought, adheres to the same method of analysis, Newton's method not only leads us to God but will also strengthen our moral fibre. There is no mistaking Newton's adherence to the alchemical fraternity in the following claim

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[120]Mircea Eliade, *The Forge and The Crucible. The origins and Structures of Alchemy*. trans. by Stephen Corrin (Chicago: The University of Chicago Press, 1978), p.232.

[121]*Opticks*, p. 402.

at the end of the *Opticks*.

> And if natural Philosophy in all its Parts, by pursuing this Method, shall at length be perfected, the Bounds of Moral Philosophy will also be enlarged.[122]

The secretive and esoteric methods of the alchemists were instituted in order to protect the common person. The alchemists, in their drive to aid nature to perfection, were in the process perfecting humanity. This is the call of the true magician. Outwardly we witness the attempt to transmute the base metals into gold. The underlying purpose is, however, the perfection of humanity. In this Newton was a key player. His goal, in natural philosophy, was to discover the first cause and, consequently, to place humanity in a formidable position to see what benefits await us. For he clearly claims this in the following passage:

> For as far as we can know by natural Philosophy what is the first Cause, what Power he has over us, and what Benefits we receive from him, so far our Duty towards him, as well as that towards one another, will appear to us by the Light of Nature. And no doubt, if the Worship of false Gods had not blinded the Heathen, their moral Philosophy would have gone farther than to the four Cardinal Virtues; and instead of teaching the Transmigration of souls ... they would have taught us to worship our true Author and Benefactor, as their Ancestors did under the Government of *Noah* and his Sons before they corrupted themselves.[123]

Finally, in the above passage we see Newton once again

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[122]*Opticks*, p.405.

[123]Ibid.

invoking the notion of a *prisca sapienta*. From his natural philosophy we are supposed to infer that we can once again breathe a sigh of relief for we will be restored to the right path to God and True knowledge -- a path from which we mistakenly deviated long, long ago.

CHAPTER IV

Conclusion

It is obvious that there is more to Newton's thought than we have grown accustomed to think. It was the object of this thesis simply to bring to the fore the claim that Newton was not the paradigm of a modern scientist. If by philosophy of science one means the study of the methodology of science, the foregoing discussion will have shown that Newton did not rely solely on classical empirical techniques. The evidence, both circumstantial and direct, is overwhelming. His resources for the solutions to the riddles of nature lay in ancient traditions, as well as alchemical experimentation. When Keynes called him the "greatest of magicians" Keynes was on the right road. I wished to show too that what has come to be known as the Newtonian method had not really arisen with Newton. In the words of the nineteenth century British philosopher of science, Whewell, Newton did not simply go out and "colligate" the facts. Nor did he simply follow methods like Mill's induction from the phenomena. Newton sought answers where others did not search. His theism was not divorced from his philosophy of nature. Does this make Newton a lesser scientist? Not in the least, and the evidence presented casts a more interesting light on him. By neglecting his "non-scientific" writings for so long, Newton scholars have done us all a disservice. I shall conclude this thesis by pointing out that historians and philosophers of science need to embark on the project of compiling and analyzing Newton's thought, a project which for me will continue.

Selected Bibliography

Primary Sources:

Newton, Isaac. *The Correspondence of Isaac Newton*. Edited by H. W. Turnbull, et. al. 7 Volumes. Cambridge:Published for the Royal Society at the University Press, 1959-78.

--------. *Isaac Newton's Papers and Letters on Natural Philosophy and Related Documents*. Edited by I. B. Cohen. Cambridge, Massachusetts: Harvard University Press, 1958.

--------. *Opticks, or A Treatise of the Reflections, Refractions, Inflections and Colours of Light*. Foreword by Albert Einstein, introduction by Sir Edmund Whittaker, preface by I.B. Cohen. Based on the 4th London Edition of 1730. New York:Dover Publications, 1952.

--------. *Sir Isaac Newton's Mathematical Principles of Natural Philosophy and His System of the World*. Translated into English from the Latin *Philosophiae naturalis principia mathematica* by Andrew Motte in 1729. The translations revised, and supplied with an historical and explanatory appendix, by Florian Cajori. 2 Volumes. Berkeley and Los Angeles:University of California Press, 1966.

--------. *Unpublished Scientific Papers of Isaac Newton. A Selection from the Portsmouth Collection in the University Library, Cambridge*. Chosen, edited, and translated by A. Rupert Hall and Marie Boas Hall. Cambridge: At the University Press, 1962.

--------. *Newton's Philosophy of Nature: Selections from His Writings*. Edited and arranged with notes by H.S. Thayer with an introduction by John Herman Randall, Jr. New York: Hafner Press, 1974.

Secondary Sources:

Acton, Henry. *The Religious Opinions and Example of Milton, Locke, and Newton*. London, 1833.

Addison, Joseph. *The Evidences of the Christian Religion... With a preface, containing the sentiments of ... Sir Isaac Newton concerning the Gospel Revelation*. London, 1730.

Alexander, H.G. *The Leibniz-Clarke Correspondence*. New York:

Manchester University Press, 1956.

Aristotle. *Metaphysics*. Translated by Richard Hope. Ann Arbor, Mich.: The University of Michigan Press, 1952.

Boyle, Robert. *Selected Philosophical Papers of Robert Boyle*. Edited by M.A. Stewart. Manchester: Manchester Press, 1979.

--------. *The Sceptical Chymist*. London: J.M. Dent & Sons, 1949.

Brasch, Frederick Edward, ed. *Sir Isaac Newton: A Bicentenary Evaluation of his Work*. Baltimore, 1928.

Brewster, Sir David. *The Life of Sir Isaac Newton*. London, 1831.

--------. *Memoirs of the Life, Writings, and Discoveries of Sir Isaac Newton (2 vols.)*. Edinburgh, 1855. Reprinted from the Edinburgh Edition of 1855 by Johnson Reprint Corporation, London, 1965.

Buchdahl, Gerd. *The Image of Newton and Locke in the Age of Reason*. London: Sheed and Ward, 1961.

Burckhardt, Titus. *Alchemy, Science of the Cosmos, Science of the Soul*. Translated by W. Stoddart. London: Stuart and Watkins, 1967.

Burland, C.A. *The Arts of the Alchemists*. New York: The Macmillan Co., 1968.

Burtt, Edwin Arthur. *The Metaphysical Foundations of Modern Physical Science*. Garden City, N.Y.: Doubleday and Company, 1955.

Butts, Robert E. and John W. Davis, eds. *The Methodological Heritage of Newton*. Toronto: The University of Toronto Press, 1970.

Carré, Meyrick H. *Phases of Thought in England*. Oxford: Clarendon Press, 1949.

Cassirer, Ernst. *The Platonic Renaissance in England*. Translated by James P. Pettergrove. Edinburgh: Nelson, 1953.

Castillejo, David. *The Expanding Force in Newton's Cosmos as Shown in his Unpublished Papers*. Madrid: Ediciones De Arte Y Bibliofilia, 1981.

Chaucer, Geoffrey. "The Canon's Yeoman", in *The Canterbury Tales*. Translated by R.M. Lumiansky. New York: Washington Square Press, 1971.

Clarke, F.P. and M.C. Nahm, eds. *Philosophical Essays in honor of Edgar Arthur Singer, Jr.* Philadelphia, University of Pennsylvania Press, 1942.

Cohen, I. Bernard. *Introduction to Newton's 'Principia'*. Cambridge, Massachusetts: Harvard University Press, 1971.

--------. *Isaac Newton's Papers and Letters on Natural Philosophy*. Cambridge Massachusetts: Harvard University Press, 1978.

--------. *The Newtonian Revolution*. Cambridge: Cambridge University Press, 1980.

--------. *The Birth of a New Physics*. New York: W.W. Norton & Company, 1985.

Cohn, Norman. *The Pursuit of the Millenium. Revolutionary Messianism in Medieval and Reformation Europe and its Bearing on Modern Totalitarian Movements*. New York: Harper Torchbooks, 1961.

Colodny, Robert G. *Beyond the Edge of Certainty*. Englewood Cliffs, New Jersey: Prentice-Hall, 1965.

Copleston, Frederick, S.J. *A History of Philosophy, Volume 5, Part I*. Garden City, New York: Image Books, 1959.

Crombie, A.C. *Augustine to Galileo, 2 vols*. London: Mercury Books, 1959.

Coudert, Allison. *Alchemy: The Philosopher's Stone*. Boulder, Co.: Shambhala Publications, 1980.

Debus, Allen G. and Robert P. Multhauf. *Alchemy and Chemistry in the Seventeenth Century*. University of California, Los Angeles: William Andrews Clark Memorial Library, 1966.

Debus, Allen G. *The Chemical Philosophy, Paracelsian Science and Medicine in the Sixteenth and Seventeenth Centuries. 2 volumes*. New York: Science History Publications, 1977.

--------. *Man and Nature in the Renaissance*. Cambridge: Cambridge University Press, 1978.

--------. *Chemistry, Alchemy and the New Philosophy, 1500-1700*. London: Variorum Reprints, 1987.

Descartes, René. *Descartes' Philosophical Writings*. Translated and edited by Elizabeth Anscombe and Peter Thomas Geach. Indianapolis: Bobbs-Merrill, 1971.

Dobbs, Mary Jo Teeter. *The Foundations of Newton's Alchemy or "The Hunting of the Greene Lyon"*. Cambridge: Cambridge University Press, 1975.

Edleston, Joseph, editor. *Correspondence of Sir Isaac Newton and Professor Cotes, including letters of other prominent men*. London, 1850.

Eliade, Mircea. *The Forge and the Crucible. The Origins and Structures of Alchemy*. Translated from the French by Stephen Corrin. Chicago: The University of Chicago Press, 1978.

Feyerabend, Paul K. *Against Method. Outline of an anarchist theory of knowledge*. London: Verso, 1978.

Force, James E. *William Whiston: Honest Newtonian*. Cambridge: Cambridge University Press, 1985.

Franz, Marie-Louise von. *Alchemical Active Imagination*. Irving, Texas: Spring Publications, 1979.

Galilei, Galileo. *Dialogues Concerning Two New Sciences*. Translated by Henry Crew and Alfonso de Salvio. New York: Dover Publications (The Macmillan Company), 1914.

Green, Henry. *Sir Isaac Newton's Views on Points of Trinitarian Doctrine; his articles of Faith, and General Coincidence of his Opinions with those of John Locke...* London, 1856.

Gregg, T.D. *The Cosmology of Sir Isaac Newton proved to be in accordance with the Bible*. London, 1871.

Grey, Zachary. *An Examination of the fourteenth Chapter of Sir Isaac Newton's Observations upon the Prophecies of Daniel*. London, 1736.

Hall, A. Rupert. *From Galileo to Newton*. New York: Dover Publications, 1981.

Harman, P.M. *Metaphysics and Natural Philosophy. The Problem of Substance in Classical Physics*. Sussex: The Harvester Press, 1982.

Hawking, Stephen W. *A Brief History of Time: From the Big Bang to Black Holes*. New York: Bantam, 1988.

Holmyard, E.J. *Alchemy*. Harmondsworth, England: Penguin Books, 1957.

Hübner, Kurt. *Critique of Scientific Reason*. Translated by Paul R. Dixon, Jr., and Hollis M. Dixon. Chicago: University of Chicago Press, 1983.

Hume, David. *On Human Nature and the Understanding*. Anthony Flew, ed. New York: Collier Books, 1962.

Jacob, Margaret C. *The Radical Enlightenment: Pantheists, Freemasons and Republicans*. London: George Allen & Unwin, 1981.

Jung, Carl Gustav. *The Collected Works of C.G. Jung, Volume 12: Psychology and Alchemy*. Translated by R.F.C. Hull. Princeton: Princeton University Press, 1980.

Keynes, John Maynard. *Essays in Biography*. Geoffrey Keynes, ed., London: Mercury Books, 1961.

Khursheed, Anjam. *Science and Religion*. London: One World Publications, 1987.

Koestler, Arthur. *The Sleepwalkers*. London: Penguin Books, 1959.

--------. *The Act of Creation*. London: Pan Books, 1964.

Koyré, Alexandre. *From the Closed World to the Infinite Universe*. Baltimore: The John Hopkins Press, 1957.

--------. *Newtonian Studies*. Cambridge, Massachusetts: Harvard University Press, 1965.

Kuhn, Thomas S. *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press, 1970.

Locke, John. *An Essay Concerning Human Understanding (2 vols.)*. New York: Dover Publications, 1959, 1690 (Oxford).

--------. *An Essay for the Understanding of St. Paul's Epistles, by consulting St. Paul himself (5 parts)*. London, 1891.

Lovejoy, Arthur O. *The Great Chain of Being. A Study of the History of an Idea*. Cambridge, Ma.: Harvard University Press, 1953.

Mach, Ernst. *The Science of Mechanics*. Chicago: The Open Court, 1946.

Manuel, Frank E. *The Eighteenth Century Confronts the Gods*. Cambridge Massachusetts: Harvard University Press, 1959.

---------. *Isaac Newton, Historian*. Cambridge, Massachusetts: Harvard University Press, 1963.

---------. *A Portrait of Isaac Newton*. Cambridge, Massachusetts: Harvard University Press, 1968.

Mathias, Peter, ed. *Science and Society, 1600 - 1900*. Cambridge: At the University Press, 1972.

McLachlan, Herbert. *The Religious Opinions of Milton, Locke and Newton*. Manchester: Manchester University Press, 1941.

---------. *Socianism in Seventeenth-Century England*. Oxford: Oxford University Press, 1951.

McMullin, Ernan. *The Concept of Matter in Modern Philosophy*. Notre Dame: Notre Dame University Press, 1963.

---------. *Newton on Matter and Activity*. Notre Dame: Notre Dame University Press, 1978.

Merkel, Ingrid and Allen G. Debus, eds. *Hermeticism and the Renaissance. Intellectual History and the Occult in Early Modern Europe*. London: Associated University Presses, 1988.

More, Henry. *Philosophical Writings of Henry More*. Edited, with introduction and notes, by Flora Isabel Mackinnon. The Wellesley Semi-Centennial Series. London: Oxford University Press, 1925.

More, Louis Trenchard. *Isaac Newton. A Biography*. London: Constable and Co., 1934.

Nagel, Ernest. *The Structure of Science. Problems in the Logic of Scientific Explanation*. New York: Harcourt, Brace and World, 1961.

Nicolson, Marjorie Hope. *Newton Demands the Muse*. Princeton: Princeton University Press, 1946.

Palter, Robert, editor. *The Annus Mirabilis of Sir Isaac Newton 1666-1966*. Cambridge, Massachusetts: The M.I.T. Press, 1970.

Scheurer, P. B. and G. Debrock, eds. *Newton's Scientific and Philosophical Legacy*. Hingham, Ma.: Kluwer, 1988.

Singleton, Charles S. ed. *Art, Science, and History in the Renaissance*. Baltimore: The Johns Hopkins Press, 1967.

Sprat, Thomas. *History of the Royal Society*. St. Louis: Washington University, 1958.

Taylor, Sherwood. *The Alchemists*. London: Heinemann, 1951.

The Royal Society. *The Royal Society Newton Tercentenary Celebrations 15-19 July 1946*. Cambridge: Cambridge University Press, 1947.

Taylor, A.E. *Elements of Metaphysics*. London: Methuen, 1946.

Thorndike, Lynn. *History of Magic and Experimental Science. Volumes VII and VIII: The Seventeenth Century*. New York: Columbia University Press, 1958.

Voegelin, Eric. *The New Science of Politics*. Chicago: The University of Chicago Press, 1952.

Voltaire, François Marie Arouet de. *Letters Concerning the English Nation*. London, 1733.

--------. *The Metaphysics of Sir Isaac Newton*. Translated by David Erskine Baker. London.

--------. *Lettres philosophiques*. Paris: Librairie Hatier, v.d.

Webster, Charles. *From Paracelsus to Newton. Magic and the Making of Modern Science*. Cambridge: Cambridge University Press, 1982.

Westfall, Richard S. *Science and Religion in Seventeenth-Century England*. New Haven: Yale University Press, 1958.

--------. *Force in Newton's Physics. The Science of Dynamics in the Seventeenth Century*. London: Macdonald, 1971.

--------. *Never at Rest. A Biography of Isaac Newton*. Cambridge: Cambridge University Press, 1980.

Westman, Robert S. and J.E. McGuire. *Hermeticism and the Scientific Revolution*. Los Angeles: William Andrews Clark Memorial Library, 1977.

Yates, Frances A. *Giordano Bruno and the Hermetic Tradition*. New York: Vintage Books, 1964.

--------. *The Rosicrucian Enlightenment*. London: Ark Paperbacks, 1986.

Articles:

Andrade, Sir E.N. da C. "Newton's Early Notebook." *Nature* CXXXV (1935): 360.

Boas, George. "Philosophies of Science in Florentine Platonism." In *Art, Science, and History in the Renaissance*, pp.239-254. Charles S. Singleton, ed. Baltimore: The Johns Hopkins Press, 1967.

Boas (Hall), Marie. "Newton and the theory of chemical solution." *Isis* 43 (1952): 123.

Boas (Hall), Marie and A. Rupert Hall. "Newton's Chemical Experiments." *Archives internationales d'histoire des sciences* 11 (1958): 113-152.

---------. "Newton's theory of matter." *Isis* 51 (1960): 131-144.

Cajori, Florian. "Sir Isaac Newton's Early Study of the Apocalypse." *Popular Astronomy* XXXIV, no. 2 (1926): .

Canadian Broadcasting Corporation Transcripts, "On the shoulder of giants", *Ideas*, December, 1987.

Churchill, Mary S. "*The Seven Chapters*, with explanatory notes." *Chymia* 12 (1967): 29-57.

Debus, Allen G. "Mathematics and nature in the chemical texts of the Renaissance." *Ambix* XV, No. 1 (February, 1968): 1-28.

--------. "Alchemy and the historian of science." *History of Science* 6 (1967): 128-38.

Dobbs, Betty Jo Teeter. "Newton's Alchemy and His Theory of Matter." *Isis* 73 (1982): 511-528.

--------. "Newton's *Commentary* on the *Emerald Tablet* of Hermes Trismegistus: Its Scientific and Theological Significance." In *Hermeticism and the Renaissance. Intellectual History and the Occult in Early Modern Europe*, pp. 182-191. Edited by Ingrid Merkel and Allen G. Debus. London: Associated University Presses, 1988.

Einstein, Albert. "The Fundaments of Theoretical Physics." In *Readings in the Philosophy of Science*, pp. 253-261. Herbert Feigl and Mary Broderick, eds. New York:

Appleton-Century-Crofts, 1953.

Forbes, R.J. "Was Newton an Alchemist?." *Chymia* 2 (1949): 27-36.

Geoghegan, D. "Some Indications of Newton's Attitude Towards Alchemy." *Ambix* 6 (1957): 102-106.

Hall, A. Rupert. "Sir Isaac Newton's Note-book, 1661-1665." *Cambridge Historical Journal* 9 (1948): 239-50.

--------. "Two Unpublished Lectures of Robert Hooke." *Isis* 42 (1951): 219-30.

Heym, Gerard. Review of *Paracelsica, Zwei Vorlesungen über den Arxt und Philosophen Theophrastus*, by Carl Gustav Jung, in *Ambix* 2 (1938-46): 196-198.

--------. Review of *Psychologie und Alchemie*, by Carl Gustav Jung, in *Ambix* 3 (1948-49): 64-67.

--------. Review of *Mysterium Coniunctionis*, by Carl Gustav Jung, in *Ambix* 6 (1957): 47-51.

Huxley, G.L. "Two Newtonian Studies." *Harvard Library Bulletin* 13 (1959): 348-361.

Johannison, Karin. "Magic, Science, and Institutionalization in the Seventeenth and Eighteenth Centuries." In *Hermeticism and the Renaissance. Intellectual History and the Occult in Early Modern Europe*, pp. 251-263. Ingrid Merkel and Allen G. Debus, eds. London: Associated University Presses, 1988.

Kuhn, Thomas S. "Robert Boyle and Structural Chemistry in the Seventeenth Century." *Isis* 43 (1952): 12-36.

--------. "Reply to Marie Boas (Hall)." *Isis* 43 (1952): 123-124.

--------. "Newton's '31st Query' and the degradation of gold." *Isis* 42 (1951): 296-298.

Laudan, L.L. "Thomas Reid and the Newtonian Twin of British Methodological Thought." In *The Methodological Heritage of Newton*, pp. 103-131. Robert E. Butts and John W. Davis, eds. Toronto: The University of Toronto Press, 1970.

Mach, Ernst. "The Economy of Physical Theory." In *Science: Men, Methods, Goals*, pp.15-22. B.A. Brody and N. Capaldi, eds. New York: W.A. Benjamin, 1968.

Macomber, Henry P. "A Comparison of the variations and errors in copies of the first edition of Newton's *Principia*, 1687." *Isis* 42 (1951): 230-32.

McGuire, J.E. "Transmutation and Immutability: Newton's Doctrine of Physical Qualities." *Ambix* 14 (1967): 69-95.

---------. "Force, Active Principles, and Newton's Invisible Realm." *Ambix* 15 (1968): 154-208.

---------. "The Origin of Newton's Doctrine of Essential Qualities." *Centaurus* 12 (1968): 233-60.

McGuire, J.E. and Rattansi, P.M. "Newton and the 'Pipes of Pan'." *Notes and Records of the Royal Society of London* 21 (1966):108-143.

McKie, Douglas. "Newton and Chemistry." *Endeavor* 1, no. 4 (October 1942): 141-144.

---------. "Some Notes on Newton's Chemical Philosophy Written Upon the Occasion of the Tercentenary of his Birth." *Philosophical Magazine* 33 (1942): 847-870.

McMullin, Ernan. "Empiricism and the Scientific Revolution." In *Art, Science, and History in the Renaissance*, pp. 331-372. Charles S. Singleton, ed. Baltimore: The Johns Hopkins Press, 1967.

Merton, Robert K. "Science, Technology and Society in Seventeenth Century England." *Osiris* 4 (1938): 360-362.

Pagel, Walter. "Jung's Views on Alchemy." *Isis* 39 (1948): 44-48.

Randall Jr., John Herman. "Newton's Natural Philosophy, Its Problems and Consequences." In *Philosophical Essays in Honor of Edgar Arthur Singer, Jr.*, pp. 335-357. F.P. Clarke and M.C. Nahm, eds. Philadelphia: University of Philadelphia Press, 1942.

Rattansi, P.M. "The Social Interpretation of Science in the Seventeenth Century." In *Science and Society, 1600-1900*, pp. 1-32. Peter Mathias, ed. Cambridge: At the University Press, 1972.

Sheppard, H.J. "Gnosticism and Alchemy." *Ambix* 6 (1957): 86-101.

Strong, Edward. "Newton and God." *Journal of the History of Ideas* 13 (1952): 147-167.

Taylor, Frank Sherwood. "An Alchemical Work of Sir Isaac Newton (Keynes MS 38)." *Ambix* 5 (1956): 59-84.

Westfall, Richard S. "Isaac Newton's Coloured Circles Twixt Two Contiguous Glasses." *Archives of the History of the Exact Sciences* 2 (1965): 181-96.

--------. "Newton and the Fudge Factor." *Science* 179 (1973): 751-58.

--------. "The Foundations of Newton's Philosophy of Nature." *The British Journal for the History of Science* 1 (1962-63): 171-82.

Whiteside, D.T. "The Expanding World of Newtonian Research." *History of Science: An Annual Review of Literature, Research and Teaching* 1 (1962): 16-29.

Yates, Frances A. "The Hermetic Tradition in Renaissance Science." In *Art, Science, and History in the Renaissance*, pp.255-274. Charles S. Singleton, ed. Baltimore: The Johns Hopkins Press, 1967.

Appendix

Tabula Smaragdina

Tis true without lying, certain & most true.

That w^{ch} is below is like that w^{ch} is above & that w^{ch} is above is like y^{t} w^{ch} is below to do y^{e} miracles of one only thing

And as all things have been & arose from one by y^{e} mediation of one: so all things have their birth from this one thing by adaptation.

The Sun is its father, the moon is its mother, the wind hath carried it in its belly, the earth is its nourse. The father of all perfection in y^{e} whole world is here. Its force or power is entire if it be converted into earth.

Separate thou y^{e} earth from y^{e} fire, y^{e} subtile from the gross sweetly w^{th} great indoustry. It ascends from y^{e} earth to y^{e} heaven & again it descends to y^{e} earth & receives y^{e} force of things superior & inferior.

By this means you shall have y^{e} glory of y^{e} whole world & thereby all obscurity shall fly from you.

Its force is above all force. For it vanquishes every subtile thing & penetrates every solid thing.

So was y^{e} world created.

From this are & do come admirable adaptations whereof y^{e} means ↗ (Or process) ↙ is here in this.

Hence I am called Hermes Trismegist, having the three parts of y^e philosophy of y^e whole world

That w^{ch} I have said of y^e operation of y^e Sun is accomplished & ended.[124]

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[124]Taken from B.J.T. Dobbs, "Newton's *Commentary* on the *Emerald Tablet* of Hermes Trismegistus: Its Scientific and Theological Significance." in *Hermeticism and the Renaissance*, Ingrid Merkel and Allen G. Debus, eds. (Cranbury, N.J.: Associated University Presses, 1988), page 183. The text included here makes use of Newton's English from the 1690's. It is taken from Keynes MS.28, fol. 2r, v.