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*The Unknown Newton*

# The Problem of Alchemy

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While Isaac Newton's status as one of the very greatest of modern scientists has never been in question, some scientists and scholars have worried that his pursuits were at times antithetical to the standards of untainted reason commonly associated with science. Concerns about Newton's commitment to rational inquiry in his study of nature were first made widely public in the middle of the twentieth century, after the economist and Newton aficionado John Maynard Keynes had acquired at auction a large number of Newton's papers dealing with alchemy. For the tercentenary celebration of Newton's birth, Keynes famously wrote in an address that

> Newton was not the first of the age of reason. He was the last of the magicians, the last of the Babylonians and Sumerians, the last great mind which looked out on the visible and intellectual world with the same eyes as those who began to build our intellectual inheritance rather less than 10,000 years ago.

The thrust of Keynes's address was that the conventional view of Newton as a "rationalist, one who had taught us to think on the lines of cold and untinctured reason," was not quite right and that the truth was more complicated: one of the greatest scientists of all time spent a large part of his most creative years on various unscientific quests, including a search for that most elusive of alchemical substances, the philosophers' stone.

Keynes's pronouncement faithfully presented not only the conventional view of Newton as a rationalist but also the mainstream view of alchemy among historians of science during the mid-twentieth century. When Keynes wrote that Newton's alchemical experimentation was an attempt "to imitate the alleged but largely imaginary experiments of the initiates of past centuries" and that it is "utterly impossible to deny that it is wholly magical and wholly devoid of scientific value," he was in fact

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echoing a commonly held view of alchemy as a whole. This view can be summed up by analytical psychologist Carl Jung's statement that alchemy largely resembled "psychic processes expressed in pseudo-chemical language," implying that something other than scientific or even material goals was the main driving force behind the aurific art.

Herbert Butterfield, in his celebrated *Origins of Modern Science* (1949), would dismiss historians of alchemy as being "tinctured with the kind of lunacy they set out to describe." Similarly, Alfred Rupert Hall (who would later become the editor of collections of Newton's unpublished scientific papers and letters), in his book *The Scientific Revolution: 1500–1800* (1954), denied alchemy any status as a forerunner to chemistry, and went so far as to describe the theory of transmutation as "the greatest obstacle to the development of a rational chemistry." And E. J. Dijksterhuis, in his important work *The Mechanization of the World Picture* (1950), could only see folly in alchemy, characterizing it as "a mysterious trifling with impure substances, guided by mystical conceptions and hazy analogies, in which credulity played a considerable part."

Despite the unanimity of these denunciations, in comparison to which Keynes's description of Newton's alchemy seems almost mild, none of them gives an accurate representation of early modern alchemy or its practitioners. Instead, they support what is still the popular view of alchemy as a partner to magic, astrology, and witchcraft in the amorphous field of "the occult." Even though the influential work of various scholars in the 1970s and 1980s—among them Betty Jo Teeter Dobbs, Richard Westfall, and Karin Figala—made it well known that Newton transcribed and composed about a million words on the subject of alchemy, to learn that the champion of modern science was deeply engaged in alchemy arouses in many even today a sense of cognitive dissonance. However, a closer study of alchemy and its practitioners in the early modern period reveals that this feeling is largely unwarranted.

## Alchemy Revisited

Part of the confusion surrounding Newton's involvement with alchemy has to do with the common error that alchemy and chemistry were at the time distinct disciplines, one essentially magical and the other scientific. Throughout the early modern period, the English terms "alchemy" and "chymistry," as it was then called, were in reality largely synonymous, and the field denoted by those terms included a great deal more than the attempt to transmute base metals into gold. Chymistry—the historically

appropriate term I will continue to use to distinguish it from the later notion of "chemistry"—was a heterogeneous discipline that combined what we would today call "chemical technology" (as in the making of pigments, refining and assaying of ores, production of salts, manufacture of strong acids, distillation of alcoholic libations, and so forth) with early modern pharmacology or *chymiatria*, and with *chrysopoeia*, which means transmutation into gold—what we usually think of as alchemy. The fundamental feature of these pursuits was their experimental approach, which was often coupled with an eye to profit. (It is striking that, according to the *Oxford English Dictionary*, the first recorded instances of the English terms "research" and "researcher" in the sense of experimental, scientific research and its practitioners both stem from chymical writers in the 1670s. The two words emerge explicitly in an exchange about the analysis of spa waters between William Simpson and Daniel Foote, two scientists in the tradition of the Flemish chymist and physician Joan Baptista van Helmont.)

Newton's chymical manuscripts (now being edited and published online at Chymistry.org) reveal that he had interests in all three branches of the discipline, not just in the transmutation of metals. He compiled extensive notes from writers on chymical medicine and even went so far as to prepare several dictionaries full of technical, metallurgical, and pharmaceutical recipes. When Keynes asserted that Newton's alchemy was devoid of scientific value, the economist was either unaware of those manuscripts or misled by the widespread view of alchemy as nothing but a misguided attempt at transmuting metals. As for Keynes's claim that Newton's alchemy was "wholly magical," this too squares poorly with more recent historical research. To many in the sixteenth and seventeenth centuries, magic and alchemy were distinct disciplines that could overlap but were not by any means identical. The concept of the occult as a category encompassing such pursuits as astrology, numerology, alchemy, and magic would not achieve its modern, if anachronistic form until the Romantic movement of the nineteenth century, with writers such as Alphonse Louis Constant (publishing as Eliphas Levi) and Mary Anne Atwood. Constant in particular exercised great influence with his claim that the language of alchemy, along with that of the other "occult sciences," was actually an encoded discussion of the "magnetic fluid," the operative principle in Franz Anton Mesmer's animal magnetism. Such a view could only erode the very real differences between alchemy and astrology, for example, the first actually being an experimental or even artisanal pursuit and the second a form of prognostication.

Nonetheless, one cannot deny that Newton's involvement in chymistry *was* dominated by alchemy in the common modern sense of the transmutation of metals. His experimental notebooks, kept in the Portsmouth Collection at the University of Cambridge, demonstrate a powerful interest on his part in the transmutation of base into precious metals, a fact that is confirmed by a consultation of the authors whom he excerpted and transcribed in other unpublished writings. In a word, Newton had an active interest in alchemical transmutation that persisted from his early years at Cambridge in the 1660s at least until his installation in London as Warden of the Mint in 1696, and probably beyond. Was Keynes therefore right, after all, in calling Newton "the last of the magicians"?

Answering this question requires that we consider not only Newton's views about transmutation but also those of his contemporaries. Robert Boyle, once thought by historians to be the very soul of skepticism with regard to alchemy, is now known to have sought the philosophers' stone for much of his adult life. Indeed, he was first taught what we now call chemistry by the remarkable but today little known alchemist George Starkey, an American immigrant from Bermuda who graduated from Harvard College in 1646 and later moved to London. Starkey also wrote under the *nom de plume* of Eirenaeus Philalethes (Peaceful Lover of Truth). Interestingly, both Boyle and Starkey were among Newton's favorite authors in the realm of chymistry, and Newton even corresponded with Boyle on the subject. Newton's friend and follower, the philosopher John Locke, was also a reader of Philalethes and a serious student of both chymical medicine and *chrysopoeia*. If Newton was a "magician," then so were Boyle, Starkey, and Locke. The same is true of Newton's archrival in the priority dispute about the calculus, Gottfried Wilhelm Leibniz. Leibniz included an interest in alchemy among his polymorphous scientific pursuits, apparently even becoming the secretary of an alchemical society in Nuremberg for a brief time. Even the rigorously rationalistic philosopher Baruch Spinoza took alchemy seriously. Upon hearing about a supposed transmutation in the Netherlands, Spinoza traveled to the silversmith who had confirmed the veracity of the event, and reported to a friend that he saw some of the gold that resulted from it.

Keynes's view of Newton as the last representative of a Mesopotamian magical tradition is severely undercut by the fact that many if not most of the best scientists and thinkers of Newton's time were also devotees or at least enthusiastic amateurs in the realm of *chrysopoeia*. It was not until the 1720s that the best chymists in Europe began *en masse* to abandon attempts at metallic transmutation, and this period coincides with the

end of Newton's own alchemical experimentation. In fact, had Keynes examined such Enlightenment chemists as Georg Ernst Stahl (father of the famous phlogiston theory) and Herman Boerhaave, he would have made the surprising discovery that they were still using the same apparatus, technology, and substances as their alchemical forebears; even their theories of matter were largely identical to those of the alchemists. What had changed was simply that *chrysopoeia* had dropped out of the eighteenth-century chemists' repertoire, perhaps in response to its having gone "down-market" as a result of its immense popularity in the immediately previous generations. By no means was Newton's involvement in alchemy the product of a singular and solitary temperament, nor was it a "rebellion"—as his most successful and celebrated modern biographer, Richard Westfall, claimed in *Never at Rest* (1980)—against the rigor and sterility of the mechanical philosophy of the time that thought of all matter as small corpuscles (particles) interacting by laws of motion. In reality, Newton tried to integrate alchemy and the mechanical philosophy in his important treatise "Of Natures obvious laws & processes in vegetation," which begins with the premise that metals "vegetate"—that is, grow—in the earth, being changed over time from one substance into another. Newton and other alchemists hoped that an understanding of these processes by experiment could help turn base into precious metals. Newton was neither the last of the magicians nor the first of the age of reason; his alchemical labors were the stock-in-trade of early modern experimental science.

## Alchemy and God

A second common misconception lies in the claim made by the historian Betty Jo Teeter Dobbs in her 1991 *Janus Faces of Genius* that Newton's alchemy was primarily an expression of his heterodox religious views, and that he thought of the philosophical mercury of the alchemists as a spirit that mediated between the physical and transcendent realms, analogous to the way Jesus mediated between man and God. As Dobbs put it in one of many similar passages in her book,

> Newton's God acted in time and with time, and since He was so transcendent, He required for His interaction with the created world at least one intermediary agent to put His will into effect. Just such an agent was the alchemical spirit, charged with animating and shaping the passive matter of the universe.

Dobbs was not the first person to argue that Newton's alchemy was part and parcel of his unorthodox religiosity. In a 1967 article, Mary Churchill was already making similar claims. Like Dobbs, Churchill relied on the ideas of Carl Jung when she wrote that "the moral and religious element in alchemy quite outweighs its technical aspect," to bolster her argument that Newton saw the alchemists as upholders of a "pristine religion" closely related to his anti-Trinitarianism. Churchill went so far as to claim that Newton considered the alchemical tradition to have been the voice of anti-Catholic protest before the advent of Protestantism, and that he viewed alchemy as holding "the soteriological secret"—that is, the secret of salvation—and a "secret creed" like his own unorthodox religious beliefs. Dobbs originally criticized Churchill on this point but in *The Janus Faces of Genius* explicitly endorsed her views and offered her an apology for the earlier skepticism.

Only in a restricted and highly qualified sense can one say that Newton's interest in alchemy had a religious origin—in the sense that his science as a whole was undoubtedly linked to his deep Christian convictions. When we examine Newton's own alchemical writings, rather than his transcribing and anthologizing of other alchemists' works, there is little indeed to support Dobbs's and Churchill's view that Newton's interest in alchemy was closely related to his heterodox religious views. To the contrary, Newton's two chymical laboratory notebooks (Cambridge University Additional manuscripts 3973 and 3975), are resolute in their avoidance of religious topics. The word "God" in English or Latin is found only once in these texts, despite the fact that they comprise 452 manuscript pages between them, and despite the fact that those pages are replete with alchemical experiments and terminology.

As for the one case where the word "God" does appear (in the second of those two manuscripts), Newton has lifted an admonition more or less verbatim from George Starkey's 1658 *Pyrotechny Asserted* where the American alchemist taunts his competitors for their technical incompetence and advises them to pray to God that they may understand his secrets. This mocking passage copied from Starkey obviously cannot be taken to support a theological character of alchemy, be it his own or that of Newton.

A more central passage for Dobbs's linkage of Newton's alchemy to his religious quest is found in Newton's manuscript "Of Natures obvious laws & processes in vegetation," a text that is derived largely from chymical sources and contains in passing a brief consideration of the limitless possibilities of the creation:

> Of God. what ever I can conceive without a contradiction, either is or may bee made by something that is: I can conceive all my owne powers (knowledge, activating matter etc) without assigning them any limits Therefore such powers either are or may bee made to bee.

Dobbs claimed that Newton inserted this discussion into an alchemical manuscript in order to explain how God could circumvent the mechanical order of the cosmos by means of "the nonmechanical laws of vegetation." According to her theocentric analysis of Newton's alchemy, this was part of an attempt on his part to demonstrate "divine activity in the world." But in fact there is nothing alchemical about this passage, and its linkage to the rest of the text is obscure. It is in reality much closer to the Descartes-inspired jottings found in Newton's commonplace notebook "Certain Philosophical Questions" from his college years than it is to his alchemical texts. A related passage can be found in that notebook at the end of Newton's notes on Descartes's *Meditations* and responses to critics' objections. Newton discusses the ramifications of the ontological proof for God's existence—the argument that God exists because the clear and distinct notion of God, a perfect being, necessarily includes his existence, without which he would not be perfect. Newton was probably thinking of the "Second Set of Objections" in particular, where a critic of Descartes raised the following concern about the ontological proof: "From this it follows not that God really exists, but only that he ought to exist if his nature is something possible or non-contradictory."* It is in light of this criticism that one should approach Newton's interest in non-contradiction in "Certain Philosophical Questions." Similarly, his passage "Of God" testifies to his encounter with Descartes's ruminations on the existence and nature of God; Newton is not making a case for non-mechanism as Dobbs asserted. What then is this passage doing in the midst of Newton's heavily alchemical text? "Of Natures obvious laws & processes in vegetation" is itself a sort of commonplace book, organized around topical entries that need not be closely related. The passage "Of God" looks more like a digression than a thought that grew integrally out of Newton's text on alchemical vegetation. Newton himself seems to have acknowledged its outlier status by leaving the rest of the page after the entry blank in his manuscript.

* The observation that the likely source for Newton's notes on non-contradiction is this objection to Descartes's *Meditations* has been brought to my attention in an extended discussion with Roger Ariew, co-editor and co-translator of a recent edition of the *Meditations* (Hackett, 2006). Gideon Manning has also found echoes of the third Meditation in Newton's comments, a fact that he has kindly related to me in a personal exchange.

In short, a close inspection of this passage, and indeed of most of the evidence used by Dobbs in support of her theocentric reading, does not support her interpretation. Rather than seeing Newton's chymistry as somehow more religious in orientation than his physics, one should view it as arising from the same desire to penetrate behind the appearances and to arrive at the most general possible explanation of reality. In the hands of Newton, both chymistry and physics were tools for arriving at fundamental truths about nature and its operations.

## Grand Ambitions

So what was Newton trying to accomplish with his tireless reading of alchemical texts and an experimental program that his laboratory notebooks show to have stretched over thirty years? Although the jury is still out, it is safe to say that his alchemical research focused on two complementary yet distinct goals, one linking his alchemical research to his more "mainstream" science, the other focusing on transmutation *per se*.

The first goal belongs primarily to Newton's youth, to the incredibly productive years that culminated in his *annus mirabilis*—the 1666 "year of wonders," in which he made many of his most important discoveries—and to the lectures and letters that announced to the world his early discoveries in optics in the following years. During this period of great creativity, Newton mined chymistry for materials that could be used in natural philosophy as a whole. Not surprisingly, Newton was deeply impressed by Robert Boyle's experiments with chymical analysis and resynthesis—the process of breaking down chemical compounds (as we would say today) into their components and recomposing them. In the very notebook in which Newton recorded his first experiments on the resynthesis of white light from the spectral colors he had derived using prisms, he also copied out Boyle's descriptions of the analysis and resynthesis of amber, antimony, and other materials. Newton's language in his 1669 lectures on optics even mimics the unusual terminology of Boyle's chymistry, revealing a clear conceptual debt. For instance, Newton speaks of the "redintegration" of white light from its spectral rays; Boyle, in the 1666 text Newton copied into his notes, used the same term for resynthesizing chemical substances. This is not altogether surprising when one considers that the young Newton viewed light as being composed of material corpuscles that were of the same nature as chymical corpuscles, though smaller. For Newton white light was a heterogeneous material that could be divided into its component parts and then recombined just

as Boyle had famously shown to be the case for niter and other chemical compounds.

During the early 1670s Newton was still working hard at his attempt at integrating chymistry into his reform of all of natural philosophy. By this time he felt confident enough to arrive at what was, essentially, a theory of everything—a physical theory that would unify and account for all known natural phenomena. Just as some current physicists employ superstring theory or other highly abstract models in their attempts to penetrate behind the appearances and arrive at the most general possible explanation of nature, so Newton used imperceptible ethereal media in his treatise "Of Natures obvious laws & processes in vegetation" to provide a unified explanation of the world. Although Newton's alchemy-based theory in that text remained at the conceptual level and was not formalized mathematically as his later physics would be, it tried to account for widely diverse phenomena, including organic life, the origin of heat and flame, the mechanical cause of gravitation, cohesion, the generation of metals and minerals, and much else, by making an appeal to a thin, material ether, or rather several ethers of graduated subtlety. Indeed, the notion of this ether in its various forms was the basis of Newton's startling idea that the globe of the earth, like "a great animall or rather inanimate vegetable, draws in aethereall breath for its dayly refreshment & vitall ferment & transpires again with gross exhalations, And according to the condition of all other things living ought to have its times of beginning youth old age & perishing." Many of these ideas would also appear in Newton's 1675 "Hypothesis explaining the properties of light," a letter sent to the Secretary of the Royal Society, Henry Oldenburg.

The second goal of Newton's alchemy was transmutation, as his early transcripts and notes reveal. In Newton's records of his experimentation found in the Portsmouth manuscripts we see him recreating a number of George Starkey's alchemical products, such as the "net" (a purple alloy of copper and metallic antimony) and the "star regulus" of antimony (a crystalline version of the metalloid produced by allowing it to cool under a thick layer of slag after refining it from its sulfide ore with the addition of iron and saltpeter at high temperature). Many alchemists whose work Newton consulted, including the influential German author Michael Maier as well as Starkey himself, believed that ancient mythology was encoded alchemy. Hence the story told by Ovid in his *Metamorphoses*, that Vulcan ensnared his adulterous wife Venus and her lover Mars in a bronze net, was understood by Starkey to describe a recipe for making the purple antimony-copper alloy. Vulcan was a *Deckname* (cover name) for the fire of

fusion, Mars was the iron employed in refining the antimony, and Venus was the copper in the alloy. Vulcan's net found its alchemical referent in the crystalline surface of the purple alloy, which has a reticulated appearance. Newton adopted Starkey's interpretation of the net of Vulcan and spent countless hours interpreting Maier's mythological lucubrations. Yet neither Maier, Starkey, nor Newton invented these cover names or their corresponding material referents; Vulcan, Mars, and Venus were conventional terms for fire, iron, and copper in the world of early modern alchemy. Here Newton was revealing his participation in the thought-world of the alchemists, including the elusive goal of transmutation, for which the "net" was supposed to be a steppingstone.

But even though Newton was deeply engaged with other alchemists' deciphering of ancient myths, he himself seems not to have been fully committed to their view that mythology was encoded alchemy. As Jed Buchwald and Mordechai Feingold explain in their recent book *Newton and the Origin of Civilization* (2012), Newton's alchemical interpretation of mythology was entirely distinct from the decipherment of myth that dominated his attempts to untangle ancient, especially biblical, chronology. In his chronological writings, Newton followed a process called euhemerism, taking ancient mythological figures such as Osiris and Isis to have been real historical people who came to be deified by their followers and mythologized. But in his alchemical writings, he interpreted the same mythological personages as material substances or processes. It seems much more likely that Newton's alchemical interpretation of myth was actually an attempt to extract the secrets of mythologically oriented alchemists such as Maier and Starkey rather than a commitment to the view that ancient mythology itself was encoded alchemy.

The immense labor that Newton devoted to the decipherment of his alchemical authorities is evident not only in his experimental records, but also in an extraordinary document that he entitled "Index Chemicus." This peculiar product of Newton's pen is not a treatise as such, nor even an index in the usual modern sense of the term, but rather a concordance of many alchemical authorities organized mainly around elusive terms that serve as headwords. Going through multiple drafts during the 1680s, it finally culminated in a document of ninety-six closely written folios. A number of its headwords, such as "Green Lyon," "Caduceus" (the staff of Hermes), "Hollow Oak" (*Quercus cava*), and "Net of Vulcan" (*Rete Vulcani*), are also found in Newton's laboratory notebooks, reflecting the close coordination between Newton the decoder of alchemical texts and Newton the experimenter. His methodology consisted of close reading

of texts, comparison of authors on individual terms and points, and experimental testing of the conjectures derived from this research. Far from being unique in this methodical combination of patient literary and experimental skills, Newton was following in the footsteps of previous alchemists such as Starkey.

The fact that Newton immersed himself in alchemical reading of ancient texts should not surprise us, as this was a necessary prerequisite for understanding the secrets of the adepts. Nor is Newton's involvement with esoteric wisdom restricted to his alchemy: the "Classical Scholia" that he intended to accompany the second edition of the *Principia* contained passages in which the ancient sage Pythagoras is said to have hidden his knowledge of the inverse square law of gravitational attraction in a discussion of the music of the spheres. Similarly, over a century before Newton, Copernicus, in his revolutionary discussion of heliocentric astronomy, had referred to ancient figures such as Hermes Trismegistus and the obscure Pythagorean Lysis as authorities on the subject of astronomy and the need for secrecy. Newton was not unusual for his time in thinking that the ancient world held important scientific secrets.

Newton's alchemy fits neither the Keynesian picture of the English natural philosopher as "the last of the magicians" nor the Dobbsian view of his alchemy as a religious quest. Instead, Newton's alchemical studies reveal an early modern scholar and experimenter hard at work in deciphering extraordinarily difficult texts and a natural philosopher attempting to integrate the fruits of this research into his overall reform of scientific knowledge. Although this view of Newton's alchemical scholarship and experimentation may be less evocative than Keynes's or Dobbs's, it conforms more closely to the depiction of Newton familiar to scholars of his physics, mathematics, and biblical studies. Throughout his divergent activities, Newton remained wedded to techniques of analysis and understanding that would be familiar to most of us today. The apparent incongruity between Newton the scientist and Newton the alchemist dissolves when we acquire a deeper understanding of alchemy and of the man himself.