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ORIGINS

Greco-Egyptian *Chemeta*

To locate the origins of alchemy, we must travel back to Egypt in the first centuries of the Christian Era. This place was no longer the Egypt of the far more ancient pharaohs and pyramid builders but a cosmopolitan, Hellenized civilization. Egypt had come under the influence of Greek culture following its conquest by Alexander the Great during his vast military campaigns of 334–323 BC. Even after Egypt's absorption into the Roman Empire in the first century BC, its dominant culture and language remained Greek. By the first century AD, its major city, Alexandria (founded in 331 BC and named for Alexander himself), had become a vibrant crossroads for cultures, peoples, and ideas. From this Eastern Mediterranean melting pot, the earliest surviving chemical texts, and even the origin of the word *chemistry* itself, date.

Many technical operations fundamental for alchemy had been developed well before its emergence. The smelting of metals such as silver, tin, copper, and lead from their ores had been practiced already for four thousand years. The making of alloys (such as bronze and brass, both

alloys of copper) and various techniques for metallurgy and metalworking had been developed to a fairly high degree. In Egypt, artisans had devised an array of processes for making and working glass, producing artificial gems, compounding cosmetics, and creating many other commercial products in what might be called an ancient chemical industry.¹ Generations of workshop laborers had devised and refined these techniques, with the tricks of the trade passed down from father to son, from master to apprentice.

The Technical Literature: The Papyri and Pseudo-Democritus

The earliest documents that scholars routinely attach to the history of alchemy bear witness to this technological and commercial background. These precious and unique texts, written in Greek on papyrus, date from the third century AD. They were discovered in Egypt in the early nineteenth century and now reside in museums in Leiden and Stockholm; hence they are called the Leiden and Stockholm Papyri.² They contain about 250 practical workshop recipes. These recipes fall into four chief categories: processes relating to gold, to silver, to precious stones, and to textile dyes, all costly articles of luxury and commerce. Significantly, most of the recipes deal with how to make *imitations* of these valuable substances: coloring silver to look like gold, or copper to look like silver; making artificial pearls and emeralds; and coloring cloth purple using cheaper imitations of the extravagantly expensive imperial purple dye made from murex snails. Since the Papyri also contain a series of tests to determine the purity of various metals, both precious and common, it is evident that the original users of these formulas clearly understood the difference between genuine and imitation articles.

We can get a better sense of what these craftsmen were doing by trying to follow in their footsteps. The eighty-seventh recipe in the Leiden Papyrus describes the “discovery of the water of sulfur.” The ancient text’s directions are these: “Lime, one dram; sulfur, previously ground, an equal quantity. Put them together into a vessel. Add sharp vinegar or the urine of a youth; heat from underneath until the liquid looks like blood. Filter it from the sediments, and use it pure.”³ The ingredients of this recipe are simple, clearly identifiable, and readily obtainable, so we can replicate the process today. After the ingredients are mixed (I found that urine works better than vinegar, by the way) and boiled gently for

about an hour, an orange-red and unpleasantly scented liquid results. Although the Leiden Papyrus does not say *how* to use the liquid, we can guess. When a polished piece of silver is dipped into it, the metal quickly becomes tawny, then golden, then coppery, then bronzy, purple, and finally brown. Impressively, the shiny brilliance of the metal remains undiminished by the color changes until the very end, and the color and sheen remain stable for long periods of time. With a little practice and careful control of the temperature and the length of time the metal is left in the solution, I succeeded in making silver look astonishingly like gold (see plate 1).⁴

The color changes result from the formation of extremely thin layers of sulfides on the metal surface, owing to the action of calcium polysulfides present in this “water of sulfur.” To be sure, similar compositions are still used occasionally today for patinating metal objects (in other words, producing changes to their surface color).

Recipes such as this one provide a necessary background to the emergence of alchemy, but they are not themselves, strictly speaking, alchemical. Alchemy, like other scientific pursuits, is more than a collection of recipes. There must also exist some body of theory that provides an intellectual framework, that undergirds and explains practical work, and that guides pathways for the discovery of new knowledge. Alchemy moreover was to be about more than making look-alikes of precious substances.

It is important to realize that these papyri are the *only* original documents currently known to survive from the Greco-Egyptian period. Despite the many books about alchemy that we know were written during that time, the only surviving testimony of that distant era comes in the form of corrupt anthologies—that is, collections of excerpts copied from original texts that are now lost. These anthologies—collectively called the *Corpus alchemicum graecum*—were compiled by Byzantine scribes, and the earliest of them dates from a time long after Greco-Roman Egypt had itself become a faded memory. The oldest surviving copy dates from around the start of the eleventh century, and many of its pages are missing. It contains excerpts from about two dozen books dating from the second to the eighth century, and is now preserved in Venice. This manuscript, called Marcianus graecus 299, is supplemented by a few later manuscripts now in Paris and elsewhere that contain additional texts or alternate readings. While priceless to scholars, these

collections represent only a frustratingly slim remainder of alchemy's foundational epoch.⁵ Equally problematic is the fact that the Byzantine compilers chose to copy what *they* thought was important—which could be neither representative of the original texts nor what the original authors themselves would have considered crucial. Hence, the overall picture of what Greco-Egyptian alchemists thought and did is skewed by the way their writings were excerpted centuries later.

The earliest text within the *Corpus alchemicum graecum* dates from about the late first or second century AD. It carries the title *Physika kai mystika*, and the text we possess is fragmentary. Its author is named as Democritus; but he is certainly not, as is sometimes claimed, the ancient philosopher of the fifth century BC famous for his notion of atoms.⁶ The title, which may have been given to it much later, is often translated as *Physical and Mystical Things*. Although that might *look* like a reasonable rendering of the Greek, it is misleading. A better translation is *Natural and Secret Things*. The Greek word *mystika* did not refer in ancient times to what we today call mystical, that is, something having a special religious or spiritual meaning, or expressing a personal experience of the ineffable. Instead, it simply meant things to be kept secret.⁷ Calling this text *Physical and Mystical Things* immediately suggests that the author was describing both material and spiritual things, but this is not the case. The *Physika kai mystika* records workshop recipes similar to those of the Leiden and Stockholm Papyri. In fact, it uses the same fourfold division of processes into those for gold, silver, gems, and dyes. This similarity of format suggests that a whole tradition of practical recipe books once existed in which this division was standard. For pseudo-Democritus, these processes are *mystika*, that is, *secret*, because they are lucrative artisanal processes—trade secrets, if you will.

Nevertheless, the text also contains an account of how the frustrated author, unable to carry out his craft adequately because his master had died before teaching him the necessary techniques, tried to contact the deceased. The attempt was only half successful. The master's shade spoke only to say that he was not allowed to relay information freely across the gulf that now divided him from the living, and that "the books are in the temple." A little later, a pillar in the temple suddenly opened up to reveal a hidden niche containing a terse expression of the master's secret knowledge: "Nature delights in nature, nature triumphs over nature,

nature masters nature.”⁸ (This is not the only tale of alchemical secrets suddenly revealed in a place of worship.) This repetitive and rather obscure phrase is used like a refrain throughout the recipes of the *Physika kai mystika*. Whatever meaning we attach to this tale of discovery, the recipes themselves remain straightforward and practical, with no trace of the mystical (in a modern sense) or the supernatural.

The Birth of Alchemy

The recipe literature such as the Papyri and the *Physika kai mystika* aims to imitate or extend precious materials. But probably during the third century AD, a crucial juncture in the emergence of alchemy was reached. At some point—no texts survive to inform us of exactly how or when this first happened—the idea of actually making *real* gold and silver emerged. This development would have seemed reasonable enough from the point of view of a worker at that time. If the water of sulfur can tinge the surface of silver to look like gold, why shouldn't there be some way to tinge it through and through—even more than that, to give silver not only the color of gold but *all* the properties of gold? The process for making gold is called *chrysopoeia*, from the Greek words *chryson poiein* (to make gold), and it is accompanied by the less common (and less lucrative) *argyropoeia*, the making of silver. The general process of transforming one metal into another is called *transmutation*.

From this point onward, alchemists had a coherent goal toward which to strive with both head and hand. They would pursue a great many things besides *chrysopoeia*, but the making of gold and silver remained one of the central goals of what would come to be called the Noble Art. The authors of the earliest alchemical treatises borrowed techniques, processes, and tools from a wide variety of contemporaneous artisans, yet they saw themselves as a group distinct from those artisans.⁹ Thus, both alchemy and alchemists acquired an independent identity in the third century.

The birth of alchemy required the union of two traditions: the practical artisanal knowledge exemplified in the recipe literature, and theoretical speculations about the nature of matter and change present in Greek natural philosophy: What is matter? How does one thing change into another? A Greek speculative tradition centering on these questions

stretched back for some seven hundred years before the emergence of alchemy. Such questions preoccupied the earliest Greek philosophers, known collectively as the pre-Socratics. The first thinker generally cited in this tradition is Thales of Miletus (sixth century BC), who claimed that all the different substances around us are really modifications of a single primordial substance that he identified as water. Many other thinkers followed Thales with their own ideas. Democritus and Leucippus (fifth century BC) proposed the concept of invisibly small *atomoi* (atoms), from which everything is composed. Empedocles (circa 495–435 BC) attributed the origin of natural substances and their transformations to four “roots” of things he called fire, air, earth, and water. These four combine in various ways and separate under the influence of forces he called love and strife. Perhaps most prominently of all, Aristotle (384–322 BC) devoted substantial attention to the nature of matter and change, devising theories and ways of thinking that would prove highly influential and fertile for further investigations.

All these Greek philosophers endeavored to explain matter’s hidden nature and to account for its unending transformations into new forms. Most of them embraced the idea that beneath the constantly changing appearances of things, there existed some sort of a stable, unchanging substrate. The notion that a single ultimate substance lies beneath all material things is known as *monism*. For Thales, this ultimate substance was water; for Democritus, imperishable atoms; for Aristotle, what he called “first matter” or “prime matter” (*prōton hylē*). Empedocles’ four elements, strictly speaking, represent a position of *pluralism*, since he implied that more than one kind of ultimate matter exists, but he nevertheless maintained the idea of a constancy beneath change. So far as we know, however, these natural philosophers had only a secondhand acquaintance with the practical knowledge of the crafts.

In the cosmopolitan crossroads of Greco-Roman Egypt, the two streams of craft traditions and philosophical traditions coexisted. Their merger—probably in the third century AD—gave rise to the independent discipline of alchemy. The intimate mingling of the two traditions is evident in the earliest substantial texts we have about chrysopoeia. These writings come from a Greco-Egyptian alchemist who would be revered as an authority for the rest of alchemy’s history, and the first about whom we have any reasonably substantial or reliable historical details: Zosimos of Panopolis.

Zosimos of Panopolis

Zosimos was active around 300 AD.¹⁰ He was born in the Upper Egyptian city of Panopolis, now called Akhmim. We know that he was not the first chrysopoeian, because his writings refer to earlier authorities, and even to rival “schools” of alchemical thought that had already developed by his time. (Of these other schools we know absolutely nothing save what he writes in criticism of them.) Zosimos is thought to have written twenty-eight books about alchemy; alas, most of what he wrote is now lost. We have only scraps: the prologue to a book titled *On Apparatus and Furnaces* (sometimes called the *Letter Omega*, under which letter it was once classified),¹¹ several chapters from other works, and scattered excerpts. Some of Zosimos’s writings are addressed to Theosebeia, a woman who seems to have been his pupil in alchemical matters, although whether she was a real person or a literary device we will never know for sure. Despite the fragmentary nature of what survives and the difficulty in interpreting it, these writings provide the best window we have onto Greek alchemy. Surprisingly, these early texts establish many concepts and styles that would remain fundamental for much of later alchemy.

Zosimos’s orientation toward a central goal (metallic transmutation), his insightful engagement with the practical problems in reaching it, his search for the means of surmounting these problems, and his formulation and application of theoretical principles clearly underscore his writings as something new and significant. While earlier texts are recipe miscellanies, Zosimos’s texts witness a coherent program of research that draws on both material and intellectual resources. He describes a wide array of useful apparatus—for distillation, sublimation, filtration, fixation, and so forth—in great detail.¹² Many of these instruments are adapted from cooking utensils or items used in perfumery or other crafts. Zosimos did not devise all these instruments himself, indicating how developed practical chrysopoeia must already have become by the start of the fourth century AD. The writings of his predecessors form a key resource for him, and he cites them frequently. One of the most prominent authorities is named Maria—sometimes called Maria Judaea or Mary the Jew—and Zosimos credits her with the development of a broad range of apparatus and techniques. Maria’s techniques include a method of gentle, even heating using a bath of hot water rather than an open flame. This simple but useful invention preserved the legacy of Maria the ancient alchemist,

not only for the rest of alchemy's history, but even down to the present day. It is her name that remains attached to the *bain-marie* or *bagno maria* of French and Italian cookery.

Several of the pieces of apparatus Zosimos describes—for example, one called the *kerotakis*—are designed to expose one material to the vapors of another. Indeed, he seems particularly interested in the action of vapors on solids. This interest is partly grounded on practical observations. Ancient craftsmen knew that the vapors released by heated *cadmia* (or calamine, a zinc-containing earth) could turn copper golden by transforming it into brass (an alloy of zinc and copper). The vapors of mercury and arsenic whiten copper to a silvery color. Perhaps knowledge of these color changes induced Zosimos to seek analogous processes that would bring about true transmutations. Guiding theories are certainly discernible in his writings. This is a crucial point to stress. Today there is a common misconception that alchemists worked more or less blindly—stumbling about mixing a little of this and a little of that in a random search for gold. This notion is far from the truth; already with Zosimos we can identify *theoretical principles* that guided his practical work, as well as *practical observations* that supported or modified his theories. Many theoretical frameworks for alchemy would develop in various times and places, and these frameworks both supported the possibility of transmutation and suggested avenues for pursuing it practically.

In the case of Zosimos, not enough of his work survives to map out his thinking fully. Yet it is clear that he viewed the metals as composed of two parts: a nonvolatile part that he calls the “body” (*sōma*) and a volatile part that he calls the “spirit” (*pneuma*). The spirit seems to carry the color and the other particular properties of the metal. The body seems to be the same substance in all metals; in one fragment Zosimos appears to equate it with the liquid metal mercury. Thus, the identity of the metal is dependent on its spirit, not its body. Accordingly, Zosimos uses fire—in distillation, sublimation, volatilization, and so on—to separate the spirits from the bodies. Joining separated spirits to other bodies would then bring about transmutation into a new metal.

Across the gulf of ages, Zosimos's observant, active, questioning mind makes itself apparent. In one passage, he notices the disparate effects of sulfur vapor on different substances, and expresses his astonishment that while the vapor is white and whitens most substances, when it is absorbed by mercury, which is itself white, the resulting composition

is yellow. Always ready to criticize his contemporaries, Zosimos chides them by saying that “they should inquire into this mystery first of all.”¹³ He likewise expresses his surprise that when the vapor of sulfur turns mercury into a solid, not only does the mercury lose its volatility and become fixed (that is, nonvolatile), but the sulfur also becomes fixed and remains combined with the mercury.¹⁴ Zosimos’s observation is now recognized as a basic principle of chemistry: when substances react with one another, their properties are not “averaged,” as they would be in a mere mixture, but instead completely changed. Clearly, Zosimos was a careful observer who thought deeply about what he witnessed experimentally.

Zosimos calls transmutation the “tingeing” of metals, and uses the word *bapbē*, from the verb *baphein*, which means “to dip” or “to dye”; he likewise calls a transmuting agent a “tincture,” that is, something able to tint or color. These word choices signal the connection of his ideas to the recipe literature, which was primarily concerned with coloring metals, stones, and cloth to produce precious (or apparently precious) objects. Accordingly, the “water of sulfur” reappears prominently in Zosimos, but now with strikingly new meanings. It is no longer a simple composition for bringing about superficial changes but rather some putative substance able to bring about real transmutation—and consequently something eagerly sought and eagerly hidden.

Here an almost ubiquitous feature of alchemy appears: *secrecy and the hiding of names*. Zosimos delights in playing with the name of this substance. Thanks to an ambiguity in the Greek language, in some contexts the name can mean either “water of sulfur” or “divine water.” In some places he intends the name to mean a transmuting agent, while in others he is clearly talking about the simple lime-sulfur composition of the recipe literature.¹⁵ In yet another place he describes it as “the silvery water, the hermaphrodite, that which flees without ceasing . . . it is neither a metal, nor a water always in movement, nor a solid body, for one cannot grasp it.”¹⁶ In this case his riddle for “divine water” seems to describe mercury, presented as the basic substrate for all metals. Elsewhere, the same term seems to have yet other meanings. In point of fact, in a Zosimos text just recently identified, the Egyptian admits freely that alchemical writers “call a single thing by many names while they call many things by a single name.”¹⁷ He notes that the production of transmuting “waters” is “the manifest secret, that which is studiously hidden.”¹⁸ The moderate level of secrecy encountered in the earlier recipe literature thus becomes

more intense and more self-conscious with Zosimos. Such secrecy would wax and wane in intensity but never disappear for the rest of alchemy's history.

To promote such secrecy, Zosimos employs a technique that would become typical for alchemical authors: the use of *Decknamen*, a German term meaning "cover names." These *Decknamen* function as a kind of code. Instead of using the common name for a substance, the alchemical writer substitutes another word—usually one that has some link, literal or metaphorical, with the substance intended. There is already some hint of this technique in pseudo-Democritus, where he uses the adjective *our* to specify a substance other than that usually meant by a common term; for example, he uses "our lead" to mean the mineral antimony (stibnite), a substance that shares some properties with lead. *Decknamen* serve a dual purpose: they maintain secrecy, but they also allow for discreet communication among those having the knowledge or intelligence to decipher the system. They simultaneously conceal *and* reveal. Consequently, *Decknamen* have to be *logical*, not arbitrary, so that they can be deciphered. If *Decknamen* could not be deciphered by readers, then total secrecy would be the result; and if the intent were to conceal information entirely, it would be far simpler for alchemists to have written nothing at all.

The encoding of information does not stop with simple replacements of the names of substances, not even in Zosimos. Perhaps the most famous fragments of the Panopolite are sometimes (and misleadingly) called his "Visions." Three fragments describe a series of five "dreams" separated by periods of waking. These dreams involve an altar shaped like a chemical vessel, various men of copper, of silver, and of lead, their violent dismemberment and death, and Zosimos's conversations with them. Much ink has been spilled trying to explain what these texts really mean. Regardless of the varied answers that have been offered over the past century or so, Zosimos himself tells us that they are allegorical descriptions of practical transmutational processes. In other words, the actors, places, and actions described are personified *Decknamen* woven into a coherent and extended narrative. Such allegorical language would remain a common feature of alchemical writing, and become especially prominent in works by European practitioners starting in the fourteenth century.

Zosimos calls his dream sequence a “prologue” intended to help the reader unveil the “flowers of speech” (*anthē logōn*) that follow. In the text as we have it today, only one practical process follows, but it appears that originally there were many more, now lost.¹⁹ In another place, Zosimos writes clearly that after “awaking” from a dream, he “understood very well; those who busy themselves with these things [the events in the dreams] are the liquids of the metallic art.”²⁰ In the book *On Sulphurs*, Zosimos uses a simile that compares the transmutation of lead into silver to a tormented man who becomes king; this image, which the text clearly links to a practical process, is very similar to those expressed in Zosimos’s second “dream.”²¹

Some modern writers have read various mystical or psychological meanings into Zosimos’s allegorical accounts, but in so doing they have largely ignored their context—both within the corpus of his writings and within his cultural milieu. Zosimos clearly states that his “dreams” have a technical meaning in the context of the transmutation of metals—the primary topic of his texts. Some scholars have even proposed plausible interpretations of the “dreams” in terms of the Panopolite’s alchemical theories and laboratory practices.²² It is certainly possible that Zosimos did in fact dream (or daydream) about the work in which he was so deeply engaged; many readers have probably had similar experiences of work-related matters reexpressing themselves in strange dreams. But it is more probable that Zosimos composed these “dreams” explicitly, much like a fiction writer works, thus creating a self-consciously allegorical “prologue” for one of his practical treatises. This practice harmonizes well with his routine use of secrecy, and in fact, immediately after reciting one of these “dreams,” he declares axiomatically that “silence teaches excellence,” as if to explain his own relative silence and to advise an analogous silence for his readers.²³ The use of dreams as a literary device was an established and popular practice in Zosimos’s day, and placing information into the form of a dream gives it a certain cachet—an air of authority and a tone of revelation.

Yet showing that the core meaning of Zosimos’s “dreams” lies in practical alchemical operations does not mean we can ignore their broader cultural context. Zosimos surely drew upon his own experience and knowledge of contemporaneous religious rites for imagery to use in this allegorical sequence. His language of altars, dismemberment, and sacrifice surely reflects something of late Greco-Egyptian temple practices.

This recognition brings up a huge point for the entire history of science: how do practitioners' philosophical, theological, religious, and other commitments manifest themselves in the study of the natural world, whether in alchemy or elsewhere? Such studies—be they alchemical or modern scientific—do not occur in a cultural vacuum, nor are practitioners somehow insulated from the conceptions, interests, and ways of thinking of their particular time and place. Chapter 7 deals with the inseparability of such matters from alchemy and indeed from all scientific pursuits more generally. For now, it suffices to take one last illustrative look at Zosimos.

There is undoubtedly a link between Zosimos and Gnosticism. Gnosticism was a diverse grouping of religious movements of the second and third centuries AD that stressed the need for revealed knowledge (*gnōsis*) to achieve salvation.²⁴ This salvific knowledge included the realization that man's inner being was of divine origin but had become imprisoned in a material body. Knowledge was necessary to overcome man's ignorance (or forgetfulness) of his origins, enabling him to begin liberating himself (that is, his soul) from subjection to the body and its passions, and to the material world and the evil forces that govern it. The Gnosticism widespread in Zosimos's Greco-Egyptian milieu surfaces clearly in two places in his writings. One is the prologue to his *On Apparatus and Furnaces*, and the other is the fragment called the "Final Account."²⁵ The question is how and to what extent Gnostic ideas play a role in Zosimos's alchemical ideas.

In the first text, Zosimos rails against a group of rival alchemists who criticize *On Apparatus and Furnaces* as unnecessary. He counters that they think this way only because they are using phony tinctures (transmuting agents) whose apparent success is actually the result of spiritual beings called daimons.²⁶ The daimons trick these errant alchemists into believing that their preparations work, and as a result they claim that the specific equipment, materials, and procedures stipulated by Zosimos are not needed for success. The daimons thus use these false tinctures to manipulate their ignorant possessors, thereby keeping them under daimonic sway and subjected to Fate (an evil force to be rejected). What true alchemists seek, Zosimos declares, are tinctures that are purely "natural and self-acting," bringing about transmutation by the operation of their natural properties alone.²⁷ To prepare these true, natural tinc-

tures, the right apparatus and the right ingredients and processes are absolutely necessary.

To drive home his point about the baleful results of allowing oneself to fall under the sway of daimons, Zosimos then gives a Gnostic account of the Fall of Man—how the original human being was deceived by maleficent spirits into being embodied as Adam. Zosimos reveals a Christian form of Gnosticism by recounting how Jesus Christ provided human beings with the knowledge needed for salvation, namely, the need to reject their “Adam” (the material body) in order to ascend again to their proper divine realm. Human imprisonment and its attendant evils thus arose in the first place from daimonic deception, just like that which now causes the errant alchemists to reject Zosimos’s book. Surely, these bad alchemists are making their own circumstances worse by blindly continuing to be duped rather than liberating themselves from daimonic control. Zosimos’s critical prologue must have originally provided an appropriate introduction to his (now lost) text about the furnaces and apparatus necessary for preparing a true transmuting tincture.

Does Gnosticism express itself visibly in Zosimos’s alchemical theories or practices? Possibly. Given the Gnostics’ fondness for casting their tenets into myth format, we could wonder if Zosimos’s choosing to put alchemical processes into an allegorical dream sequence arises from the same tendency to mythologize doctrines—Gnostic or alchemical. Additionally, Zosimos’s guiding theory of the twofold nature of metals (body and spirit) and the practical need to free the active, volatile soul from the heavy, inert body in order to achieve transmutations seems to parallel Gnostic views—and some other contemporaneous theological views—of man’s divine soul as being trapped in a material body, and the consequent need to free it. For a Gnostic (or a Platonist, for that matter, and Zosimos wrote about Plato as well), human individuality and personality are found in the soul, not the body. In the same way, the metals draw their particular nature and identity from their *pneuma*, not their *sōma*.

We completely miss the fullness and multivalent complexity of pre-modern thought if we dissect it into modern categories. Zosimos had no reason to isolate his philosophical or theological commitments into special categories separated from the balance of his thought. Today there is a tendency to imagine that such “mixing” (it is mixing only from our perspective) somehow impedes rational and clearheaded work on practical

matters, yet this is not only a modern prejudice but also far from true. Zosimos's methods—like anyone else's—of thinking about, conceiving, and interpreting his work could not help but be influenced by, and draw on, the totality of the way in which he conceived of the world as a whole. Thus, it is incorrect to say that alchemy for Zosimos was itself a religion, and an exaggeration to say that his alchemy was Gnostic. Yet it is equally wrong to imagine that Zosimos could (or should) “turn off” his ways of thinking, his mental landscape built upon contemporaneous Gnostic, Platonic, and other commitments, when at work on practical alchemical processes. Even modern scientists cannot do that, although some of them convince themselves that they can (perhaps under the trickery of a daimon named Pure Objectivity).

Before we leave Zosimos's time and place, there is one more piece of context to add. If scholars are correct to date Zosimos's activity to around 300 AD, then he witnessed not only Emperor Diocletian's violent suppression of a rebellion in Egypt in 297–98 but also the attempted destruction of alchemy's literary heritage by the same emperor. It is reported that Diocletian ordered all “books written by the Egyptians on the *cheimeia* of silver and gold” to be burned. The source, an account of the martyrdom of Christians during Diocletian's persecutions, claims that this measure was taken to prevent the Egyptians from amassing enough wealth to rebel again.²⁸ However, if indeed this book burning took place as reported, it may have been related to Diocletian's empire-wide monetary reforms, which included the replacement in 295–96 of Egyptian provincial coins (minted at Alexandria) with standard Roman currency.

The third century AD witnessed a steady monetary collapse for the Roman Empire. Mints increasingly debased the currency by striking coins containing less and less precious metal, thus widening the gap between the coins' face value and their intrinsic worth. The amount of silver in the coin called the *antoninianus*, for example, dropped from 52 percent to less than 5 percent. Many issues of bronze coins were given a superficial silver (or merely silvery) coating to make them appear to be worth more than they really were. Diocletian's solution (which ultimately proved unsuccessful) was to issue new coinage.²⁹ Since the Egyptian books often described means of mimicking precious metals, hiding the debasement of alloys, or—in the ideal case—producing new gold and silver, it seems that these sorts of processes would be the last thing a ruler intent

on monetary stabilization would want to have around, especially in the hands of a rebellious province of the empire. Significantly, a substantial number of late antique coins made of imitation precious metal have recently been identified, and the composition of some of them is strikingly similar to what would be produced following the recipes in the Papyri and pseudo-Democritus.³⁰ If the fear of counterfeiting and currency debasement lay behind Diocletian's decree, it would be the first in a long line of concerns over the value of currency that resulted in proscriptions against alchemy. The imperial edict banning books about *cheimeia* might also provide some of the background for the enhanced level of secrecy apparent in Zosimos's writings.

Whether or not this last suggestion is correct, one feature of this account remains: it is one of the earliest usages we have of a term—*cheimeia*—from which the words *alchemy* and *chemistry* derive. It is now time to say something about these two words. As with so much of alchemy, many unreliable claims have been made about their origin. This situation dates to the alchemists themselves, who loved to indulge in drawing fanciful etymologies in order to make various claims about their discipline. A common practice in antiquity was to trace the name of a thing to that of a mythical founder—hence Rome draws its name from the mythical Romulus, for example. Zosimos refers to an early alchemist named Chēmēs or Chymēs, and in another passage claims that the art was initially revealed by an angel in a book titled *Chēmeu*.³¹ Zosimos undoubtedly drew the germ of this notion from the apocryphal Hebrew *Book of Enoch* (or 1 Enoch), wherein fallen angels teach the productive arts to mankind. But even modern texts about the history of alchemy or chemistry often present unlikely origins. One popular notion is that *chemistry* derives from the Coptic word *kheme*, meaning “black,” alluding to the “black land,” Egypt, in reference to the color of Nile silt. There is some support for this notion, since the first-century-AD writer Plutarch notes that *chēmia* was an old name for “Egypt.”³² Hence, according to this theory, *chemistry* would literally mean “the Egyptian art.” Less plausibly, others have linked this derivation to the “black stage,” a crucial step toward effecting transmutation, or to the imagined nature of alchemy as a “black art.”

But the word more likely has a Greek origin, given that Greek was the language both of the earliest alchemical texts and of literate Greco-Roman Egypt. The “chem” of *alchemy* and *chemistry* very probably

derives from the Greek *cheō*, which means “to melt or fuse.” *Cheō* also gives rise to the Greek word *chuma*, which signifies an ingot of metal. Since most of the early chemical practices involved the melting or fusing of metals, this etymology certainly seems the most plausible and reasonable. The Greek word for the subject is then *chemeia* or *chumeia*, literally an “art of melting [metals].” (A predominantly Greek etymology does not, however, rule out a double meaning that draws also on the Coptic root.) By the way, the use of the word *alchemy* in referring to the Greco-Egyptian period could be seen as an anachronism, since that word is an Arabized form of the older Greek term—the “al” of *alchemy* is simply the Arabic definite article. (So what Zosimos and his contemporaries practiced should perhaps be called “chemy” . . .) But more on terminology later.³³

Later Alexandrian and Byzantine Authors

Several Greek texts about *chemeia* dating from after the time of Zosimos down to the eighth century survive.³⁴ Most are commentaries on earlier material, and as is the case with so much of early alchemy, several of their authors await further and more careful study. One important development within this material is a greater melding of the practical with the theoretical and philosophical. From Olympiodoros, a writer of the sixth century AD, we have a fragmentary commentary on a now-lost work of Zosimos. This Olympiodoros may very well be the philosopher of the same name who wrote commentaries on Aristotle. He followed the lead of earlier Greek thinkers—such as Thales—who sought to identify a universal material from which everything is made. Olympiodoros reorients this idea of a common material substrate to speak of a common “matter of metals,” which, by being receptive to a variety of different qualities, gives rise to the various metals. Thus, transmutation would be accomplished by reducing a metal to its “common metallic matter” and then introducing the qualities of the desired metal. This idea of a common metallic matter subject to interchangeable sets of qualities seems a continuation of Zosimos’s division of metals into “body” and “spirit.” Interestingly, Olympiodoros also justifies the use of allegory in place of plain language in alchemy by noting how Plato himself used the same literary device when teaching his most important points.³⁵

Stephanos of Alexandria, a Neoplatonic philosopher, commentator,

astronomer, and scholar, wrote an alchemical work titled *On the Great and Sacred Art of Making Gold*, which has recently been dated to 617. In this book he explicitly applies ideas from Plato, Aristotle, and other notable Greek philosophers to alchemy.³⁶ Unlike Zosimos, however, neither Olympiodoros nor Stephanos seems to have been interested in practical work. Alchemy did not constitute their main interest; they were philosophical thinkers first. Accordingly, chrysopoeia was for them a philosophical issue, and perhaps we might think of them—at least from what we know presently—as armchair alchemists. Nevertheless, their application of Greek philosophical thought, especially regarding matter, to alchemy continued the construction of an increasingly sophisticated theoretical framework for chrysopoeia. Such developments were significant not just in themselves, but also because these later versions of alchemy would be inherited by the Arabic world.

An often-reproduced image that comes from Marcianus graecus 299 is probably an emblematic expression of the philosophical principle upon which so much Greek alchemical theory and practice is based. This figure is known as the *ouroboros*, a serpent swallowing its tail (fig. 1.1). Interpretations of this simple but arresting image vary widely. But the

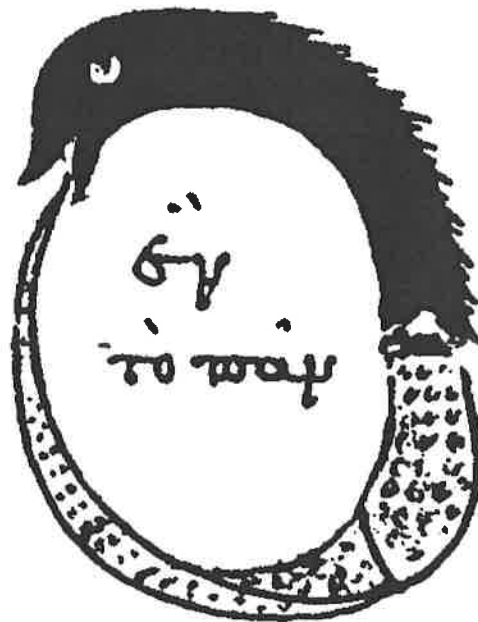


Figure 1.1. The *ouroboros* from Marcianus graecus 299, fol. 188v. Reproduced in Marcellin Berthelot, *Collection des alchimistes grecs* (Paris, 1888), 1:132.

inscription within it—ONE THE ALL (*hen to pan*)—directs us again toward ancient Greek philosophical notions about a single material that serves as the underlying substrate for all substances. Clearly, this principle undergirds the idea of alchemical transmutation: one thing can be turned into another because at the deepest level they are really the same thing. Thus, as things appear to pass away and new things come to be, there is a sense in which they remain always the same: one thing is all things, all things are one thing. Thus, the serpent *ouroboros*, like the sum total of material substances, continuously consumes itself and produces itself from itself, remaining constant even while perpetually destroying and regenerating itself.

One other development is worth mentioning before departing the Greek-speaking world for the Arabic: new names for a specific substance that would bring about transmutation. In Zosimos, this substance is one of several things he meant by the phrase “water of sulfur.” Another term he uses is *xērion*, which originally meant a medicine in the form of a powder to be sprinkled on wounds. This term may have been chosen for its relation to the word *pharmakon* (drug, salve, poison), occasionally used by pseudo-Democritus for various substances able to color metals. But the term *xērion* suggests another parallel, namely, that just as medicine heals and improves sick human beings, *chemeia* heals and improves base metals by the use of its own “medicine,” the *xērion* or transmuting agent. This powerful agent of transmutation would acquire a new and more enduring name that appeared no earlier than the seventh century: *bō lithos tōn philosophōn*, the Philosophers’ Stone. Discovering how to prepare that “stone which is no stone” would become the alchemists’ paramount goal.³⁷

Chapter One

All translations in the text from Latin, German, French, Italian, and Greek are my own unless otherwise noted.

1. Alfred Luca and John R. Harris, *Ancient Egyptian Materials and Industries* (London: Arnold, 1962); Martin Levey, *Chemistry and Chemical Technologies in Ancient Mesopotamia* (Amsterdam: Elsevier, 1959); Marco Beretta, *The Alchemy of Glass: Counterfeit, Imitation, and Transmutation in Ancient Glassmaking* (Sagamore Beach, MA: Science History Publications, 2009), 1–22; Peter van Minnen, “Urban Craftsmen in Roman Egypt,” *Münstersche Beiträge zur antiken Handelsgeschichte* 6 (1987): 31–87; Paul T. Nicholson and Ian Shaw, eds., *Ancient Egyptian Materials and Technology* (Cambridge: Cambridge University Press, 2000); Fabienne Burkhalter, “La production des objets en métal (or, argent, bronze) en Égypte Hellénistique et Romaine à travers les sources papyrologiques,” in *Commerce et artisanat dans l’Alexandrie hellénistique et romaine*, ed. Jean-Yves Empereur (Athens: EFA, 1998), pp. 125–33; and Robert Halleux, *Le problème des métaux dans la science antique* (Paris: Les Belles Lettres, 1974).

2. The most recent and reliable edition of these papyri (with French translation) is Robert Halleux, *Les alchimistes grecs I: Papyrus de Leyde, Papyrus de Stockholm, Recettes* (Paris: Les Belles Lettres, 1981). There exist older English translations in Earle Radcliffe Caley, “The Leiden Papyrus X: An English Translation with Brief Notes,” *Journal of Chemical Education* 3 (1926): 1149–66, and “The Stockholm Papyrus: An English Translation with Brief Notes,” *Journal of Chemical Education* 4 (1927): 979–1002.

3. Halleux, *Les alchimistes grecs*, pp. 104–5. The Greek name of the substance is ambiguous; in many contexts it can be translated as either “water of sulfur” or “divine water”; see below.

4. Should any readers wish to try this for themselves, take calcium hydroxide (5 g) and sulfur (5 g), and mix with 100 ml of fresh urine (if you’re squeamish about that, try 100 ml of distilled white vinegar instead). Boil very gently in a well-ventilated space for one hour, and filter the solution while hot. It takes a bit of trial and error to use the liquid effectively, but the surface color produced can be surprisingly stable and long lasting.

5. This body of Greek texts was edited (with French translation) by the chemist Marcellin Berthelot and C. E. Ruelle in their *Collections des alchimistes grecs*, 3 vols. (Paris, 1887–88). Their pioneering work has often been criticized, and on reasonable grounds; the translations are frequently unsound, and the Greek texts often inaccurate. Yet it remains the only available source for many of the texts, since only some of them have received better attention since. On the manuscripts, see Michèle Mertens, *Les alchimistes grecs IV, i: Zosime de Panopolis, Mémoires authentiques* (Paris: Les Belles Lettres, 2002), pp. xx–xlii; Henri Dominique Saffrey, “Historique et description du manuscrit alchimique de Venise Marcianus graecus 299,” in *Alchimie: Art, histoire, et mythes*, ed. Didier Kahn and Sylvain Matton, Textes et Travaux de Chrysopoeia 1 (Paris: SÉHA; Milan: Archè, 1995), pp. 1–10; and A. J. Festugière, “Alchymia,” in *Hermétisme et mystique païenne*, ed. A. J. Festugière (Paris: Les Belles Lettres, 1967), pp. 205–29. For an extensive list of Greek alchemical manuscripts, see Joseph Bidez et al., eds., *Catalogue des manuscrits alchimiques grecs*, 8 vols. (Brussels: Lamertin, 1924–32).

6. Matteo Martelli, “L’opera alchemica dello Pseudo-Democrito: Un riesame del testo,” *Eikasmos* 14 (2003): 161–84; “Chymica Graeco-Syriaca: Osservazioni sugli scritti

alchemici pseudo-Democritei nelle tradizioni greca e sirica,” in *‘Uyūn al-Akbbār: Studi sul mondo Islamico; Incontro con l’altro e incroci di culture*, ed. D. Cevenini and S. D’Onofrio (Bologna: Il Ponte, 2008), pp. 219–49; and Christoph Lüthy, “The Four-fold Democritus on the Stage of Early Modern Europe,” *Isis* 91 (2000): 442–79. An English translation of the *Physika kai mystika* was published in 1890, but it is incomplete and often misleading; Robert B. Steele, “The Treatise of Democritus on Things Natural and Mystical,” *Chemical News* 61 (1890): 88–125. A much-needed critical edition with Italian translation has recently been published by Matteo Martelli, ed., *Pseudo-Democrito: Scritti alchemici, con il commentario di Sinesio; Edizione critica del testo greco, traduzione e commento*, Textes et Travaux de Chrysopoeia 12 (Paris: SÉHA; Milan: Archè, 2011); an English version including new material from Syriac versions is now in preparation by the same scholar. Martelli (pp. 99–114) also disposes of the earlier notion, frequently repeated in the literature, that the *Physika kai mystika* was written by one Bolos of Mende, a Greco-Egyptian author of the third and second centuries BC.

7. Originally, the word was used in relation to the material details of religious rituals, but by the start of the Christian Era it had come to refer to anything that required laborious activity to uncover. Louis Bouyer, “Mysticism: An Essay on the History of a Word,” in *Understanding Mysticism* (Garden City, NY: Image Books, 1980), pp. 42–55.

8. Martelli, *Scritti alchemici*, pp. 184–87.

9. See the linguistic analysis by Matteo Martelli in “Greek Alchemists at Work: ‘Alchemical Laboratory’ in the Greco-Roman Egypt,” *Nuncius* 26 (2011): 271–311, esp. 282–84.

10. The most reliable and extensive treatment of Zosimos’s Greek texts is Mertens, *Les Alchimistes grecs IV, i: Zosime*. Some Zosimos texts not treated by Mertens but published by Berthelot, *Collections*, 117–242, await more critical editions.

11. Recent scholarship suggests that Zosimos organized his writings toward the end of his life, classifying his writings under the twenty-four letters of the Greek alphabet and adding prologues to each (either as introductions or as responses to criticism). He then added four final books to create the ensemble of twenty-eight alluded to by the *Suda*, a tenth-century Byzantine encyclopedia. We currently possess fragments known to have been classed under omega, and references to sigma and kappa. See Mertens, *Les Alchimistes grecs IV, i: Zosime*, pp. ci–cv.

12. A careful and insightful analysis of Zosimos’s apparatus, including clear illustrations, is given in *ibid.*, pp. cxiii–clxix; see also Martelli, “Greek Alchemists.”

13. Mertens, *Les Alchimistes grecs IV, i: Zosime*, p. 12. The whitening by sulfur vapor may be a reference to the bleaching ability of sulfur dioxide (produced from burning sulfur); newspaper is still bleached by that method today.

14. The reference is to the production of mercuric sulfide, which is a solid (unlike liquid mercury) and far less volatile than sulfur.

15. See Matteo Martelli, “‘Divine Water’ in the Alchemical Writings of Pseudo-Democritus,” *Ambix* 56 (2009): 5–22, and Cristina Viano, “Gli alchimisti greci e l’acqua divina,” *Rendiconti della Accademia Nazionale delle Scienze. Parte II: Memorie di scienze fisiche e naturali* 21 (1997): 61–70.

16. Mertens, *Les Alchimistes grecs IV, i: Zosime*, p. 21. On his use of “hermaphrodite,” see chapter 3, note 69.

17. In an exciting recent development, several long-lost texts of Zosimos have been identified in Arabic translation. These documents, along with many others spuriously attributed to Zosimos, have been known for some time (Manfred Ullmann, *Die Natur- und Geheimwissenschaften im Islam* [Leiden: Brill, 1972], pp. 160–64), but their authenticity has only recently been established by Benjamin Hallum (“Zosimos Arabus,” PhD diss., Warburg Institute, 2008). These will be edited and published in due course. I quote here from the “Twenty-Sixth Epistle,” p. 366.

18. Mertens, *Les Alchimistes grecs IV, i: Zosime*, p. 17.

19. *Ibid.*, pp. 40–41.

20. *Ibid.*, p. 47.

21. Hallum, “Zosimos Arabus,” pp. 130–47, quoting from pp. 142–43; compare with the interpretation given by Mertens, *Les Alchimistes grecs IV, i: Zosime*, p. 45, note 19. *On Sulphurs* may prove to be the only complete or nearly complete work of Zosimos that survives, and has already been shown to be the original source for two isolated fragments previously known in Greek.

22. Mertens, *Les Alchimistes grecs IV, i: Zosime*, pp. 207–31.

23. *Ibid.*, p. 41.

24. On Gnosticism, see Wouter J. Hanegraaff, Antoine Faivre, Roelof van den Broek, and Jean-Pierre Brach, eds., *The Dictionary of Gnosis and Western Esotericism* (Leiden: Brill, 2005), 1:403–16 and references therein.

25. A good English translation of this prologue exists as Zosimos of Panopolis, *On the Letter Omega*, ed. and trans. Howard M. Jackson (Missoula, MT: Scholars Press, 1978); a more rigorously critical edition, with commentary, is in Mertens, *Les Alchimistes grecs IV, i: Zosime*, pp. 1–10. The “Final Account” is edited (with French translation) in Festugière, *Révélation*, pp. 275–81, 363–68. For further analysis see Daniel Stolzenberg, “Unpropitious Tinctures: Alchemy, Astrology, and Gnosis according to Zosimos of Panopolis,” *Archives internationales d’histoire des sciences* 49 (1999): 3–31.

26. In classical thought, daimons are immaterial beings occupying an intermediate rank between the gods and men. Their moral proclivities might be either benign or wicked (Socrates referred to a daimon that gave him valuable advice), but in Zosimos’s cosmological view they seem always to be intent on keeping men enslaved. His perspective may reflect the influence of Jewish and/or Christian ideas.

27. Zosimos, “Final Account,” in Festugière, *Revelation*, p. 366.

28. *Acta sanctorum julii* (Antwerp, 1719–31), 2:557; John of Antioch, *Iohannes Antiocheni fragmenta ex Historia chronica*, ed. and trans. Umberto Roberto (Berlin: De Gruyter, 2005), fragment 248, pp. 428–29.

29. C. H. V. Sutherland, “Diocletian’s Reform of the Coinage: A Chronological Note,” *Journal of Roman Studies* 45 (1955): 116–18; Juan Carlos Martínez Oliva, “Monetary Integration in the Roman Empire,” in *From the Athenian Tetradrachm to the Euro*, ed. P. L. Cottrell, Gérasimos Notaras, and Gabriel Tortella (Burlington, VT: Ashgate, 2007), pp. 7–23, esp. pp. 18–22.

30. Paul T. Keyser, “Greco-Roman Alchemy and Coins of Imitation Silver,” *American Journal of Numismatics* 7–8 (1995): 209–33.

31. From a fragment of Zosimos cited in the ninth century by Georgos Synkellos, *Chronographia*, 1:23–24; for analysis, see Mertens, *Les Alchimistes grecs IV, i: Zosime*, pp. xciii–xcvi. We do not know the context in which Zosimos originally wrote this idea.

32. Plutarch, *De Iside et Osiride*, 33:364C.

33. Robert Halleux, *Les textes alchimiques* (Turnhout, Belgium: Brepols, 1979), pp. 45–47.

34. For an overview see Michèle Mertens, “Graeco-Egyptian Alchemy in Byzantium,” in *The Occult Sciences in Byzantium*, ed. Paul Magdalino and Maria Mavroudi (Geneva: La Pomme d’Or, 2006), pp. 205–30.

35. Cristina Viano, “Les alchimistes gréco-alexandrins et le *Timée* de Platon,” in *L’Alchimie et ses racines philosophiques: La tradition grecque et la tradition arabe*, ed. Cristina Viano (Paris: Vrin, 2005), pp. 91–108; “Aristote et l’alchimie grecque,” *Revue d’histoire des sciences* 49 (1996): 189–213; *La matière des choses: Le livre IV des Météorologiques d’Aristote et son interprétation par Olympiodore* (Paris: Vrin, 2006), esp. appendix 1, pp. 199–208: “Olympiodore l’alchimiste”; “Olympiodore l’alchimiste et les Présocratiques,” in *Alchemie: Art, histoire, et mythes*, ed. Didier Kahn and Sylvain Matton (Paris: SÉHA, 1995), pp. 95–150; and “Le commentaire d’Olympiodore au livre IV des *Météorologiques* d’Aristote,” in *Aristoteles chemicus*, ed. Cristina Viano (Sankt Augustin, Germany: Academia Verlag, 2002), pp. 59–79.

36. There has been a long debate whether the Stephanos of the *Corpus alchemicum graecum* is the same person as the Neoplatonic philosopher Stephanos. The most recent evidence leads to the conclusion that he is. See Maria K. Papathanassiou, “L’Oeuvre alchimique de Stephanos d’Alexandrie,” in Viano, *L’Alchimie et ses racines*, pp. 113–33; “Stephanos of Alexandria: On the Structure and Date of His Alchemical Work,” *Medicina nei secoli* 8 (1996): 247–66; and “Stephanos of Alexandria: A Famous Byzantine Scholar, Alchemist and Astrologer,” in Magdalino and Mavroudi, *Occult Sciences*, pp. 163–203. A rough English translation is available in Frank Sherwood Taylor, “Alchemical Works of Stephanos of Alexandria, Part I,” *Ambix* 1 (1937): 116–39, and “Part II,” *Ambix* 2 (1938): 39–49.

37. The phrase “stone that is no stone” appears in Zosimos (Mertens, *Les alchimistes grecs IV, i: Zosime*, p. 49). Note that the correct term is *Philosophers’ Stone*, not the commonly encountered *Philosopher’s Stone*. All original sources in various languages use the plural possessive: *Stone of the Philosophers*.

Chapter Two

1. Marcellin Berthelot, Rubens Duval, and O. Houdas, *La chimie au moyen âge*, 3 vols. (Paris, 1893).

2. For a good treatment of the translation movement, see Dimitri Gutas, *Greek Thought, Arabic Culture: The Graeco-Arabic Translation Movement in Baghdad and Early ‘Abbasid Society* (London: Routledge, 1998). For a quicker introduction, see David C. Lindberg, *The Beginnings of Western Science*, 2nd ed. (Chicago: University of Chicago Press, 2007), pp. 166–76.

3. This information comes from the *Catalogue (al-Fibrīst)* composed in 987 by the Baghdad bookseller Ibn al-Nadīm, one of the greatest resources for bibliographers of Arabic sources. An English translation of the section covering alchemy is J. W. Fück, “The Arabic Literature on Alchemy according to An-Nadīm,” *Ambix* 4 (1951): 81–144; this section contains an early version of the story of Khālīd and his books on p. 89 and in the notes on p. 120.

4. Morienus, *De compositione alchemiae*, in *Bibliotheca chemica curiosa*, ed. J. J. Manget (Geneva, 1702; reprint, Sala Bolognese: Arnoldo Forni, 1976), 1:509–19; Ullmann, *Natur- und Geheimwissenschaften*, pp. 191–95; Ahmad Y. al-Hassan, “The