1 The Islamic Scientific Tradition: Question of Beginnings I

This chapter and the next address one of the most interesting aspects of Islamic civilization: the rise of a scientific tradition that was crucial to the development of universal science in pre-modern times. These chapters are connected by a common title, to indicate their interdependence. This first chapter surveys the various theories that have confronted the question of why and when this scientific tradition came into existence. It begins with a detailed account of the theories. The critique that follows addresses their failure to account for the facts as we know them from the primary scientific and historical sources of early Islamic times; it also lays the foundation for an alternative explanation of those facts in the next chapter. Because of this structure, the reader may encounter many unanswered questions in the first chapter, and will be repeatedly asked to await the answers that will come in the second.

There is hardly a book on Islamic civilization, or on the general history of science, that does not at least pretend to recognize the importance of the Islamic scientific tradition and the role this tradition played in the development of human civilization in general. Authors differ in how much space they allocate to this role, but they all seem to agree on a basic narrative, to which I will refer as *the classical narrative*. The main outline of this narrative goes back to medieval and Renaissance times and has been repeated over and over again.

The narrative seems to start with the assumption that Islamic civilization was a desert civilization, far removed from urban life, that had little chance to develop on its own any science that could be of interest to other cultures. This civilization began to develop scientific thought only when it came into contact with other more ancient civilizations, which are assumed to have been more advanced, but with a particular nuance to "advanced." The ancient civilizations in question are the Greco-Hellenistic civilization on the western edge of, and overlapping with, the geographical domain of the Islamic civilization, and the Sasanian (and by extension the Indian) civilization to the east and the southeast. These surrounding civilizations are usually endowed with considerable antiquity, with high degrees of scientific production (at least at some time in their history), and with a degree of intellectual vitality that could not have existed in the Islamic desert civilization.

This same narrative never fails to recount an enterprise that was indeed carried out during Islamic times: the active appropriation of the sciences of those ancient civilizations through the willful process of translation. And this translation movement is said to have encompassed nearly all the scientific and philosophical texts that those ancient civilizations had ever produced.

The classical narrative then goes on to recount how those translations took place during the early period of the Abbasid times (circa 750–900 A.D.) and how they quickly generated a veritable golden age of Islamic science and philosophy.

In this context, very few authors would go beyond the characterization of this Islamic golden age as anything more than a re-enactment of the glories of ancient Greece, and less so the glories of ancient India or Sasanian Iran. Some would at times venture to say that Islamic scientific production did indeed add to the accumulated body of Greek science a few features, but this addition is usually not depicted as anything the Greeks could not have done on their own had they been given enough time. Nobody would, for example, dare to suggest that the scientists who worked in Islamic times could have produced a new kind of science (in contrast with the science that was practiced in classical Greek times), or to imply that those scientists may have come to realize, from their later Islamic vantage point, that the very same Greek science, which became available to them through the long process of translation, was in itself deficient and fraught with contradictions.

The classical narrative, however, persists in imagining that the Islamic science that was spurred by these extensive translations was short-lived as an enterprise because it soon came into conflict with the more traditional forces within Islamic society, usually designated as religious orthodoxies of one type or another. The anti-scientific attacks that those very orthodoxies generated are supposed to have culminated in the famous work of the eleventh-twelfth-century theologian Abū Ḥāmid al-Ghazālī (d. 1111). The major work of Ghazālī that is widely cited in this regard is his *Tahāfut al-Falāsifa* (Incoherence of the Philosophers), which is sometimes also mistakenly referred to as *tahāfut al-falsafa* (incoherence of philosophy).

By sheer luck and proverbial serendipity, the Latin West was beginning to awaken around the same time. And this awakening set in motion a translation movement that identified and translated major Arabic philosophical and scientific texts into Latin during a period that has come to be known at times as the Renaissance of the twelfth century. Some of the texts that were translated into Latin during this period had already been translated from much earlier Greek and Sanskrit texts into Arabic. I am thinking in particular of such major Greek works as the *Almagest* of Ptolemy (d. ca. 150 A.D.) and the *Elements* of Euclid (d. ca. 265 B.C.), which had been translated into Arabic more than once during the ninth century, and of the passage of the Indian numerals via Arabic to Europe, where they came to be known as "Arabic" numerals.

The classical narrative goes on to postulate that from then on Europe had no need for Arabic scientific material, and that the Islamic scientific tradition was beginning to decline under the onslaught of the works of Ghazālī and thus was no longer deemed important by other cultures. In the grand scheme of things, the European Renaissance was then characterized as a deliberate attempt to bypass the Islamic scientific material, in another act of "appropriation" so to speak, and to reconnect directly with the Greco-Roman legacy, where almost all science and philosophy began, and where the European Renaissance could find its wellsprings.

Critique of the Classical Narrative

In what follows, I would like to subject this classical narrative to some criticism and to point to some of the problems that it fails to solve, before I propose, in the next chapter, an alternative narrative that, I believe, accounts for the historical facts in a much more comprehensive fashion. I do so because the classical narrative leaves us with some unresolved problems that we cannot afford to leave unsettled if we ever wish to understand the actual process by which Islamic science came into being when it did, and in a more general fashion the process by which science, in general, is born and nourished in any society. But in order to do that, first I have to deconstruct some of the basic tenets of this classical narrative.

That Islamic civilization was isolated in a desert environment is an oversimplification. As is well known, Islamic civilization came into being around the cities of Mecca and Medina and around northern Arabian tribal areas and cities that were not exactly desert steppes. Within that environment the pre-Islamic Arabian civilization had already developed some basic astronomical and medical sciences that survived well into Islamic times. In a chapter that was written about 15 years ago but not published until 2001, I tried to summarize the scientific knowledge of pre-Islamic Arabia, and came to the conclusion that the sciences that could be documented there were not much different in quality from the sciences of the surrounding regions of Byzantium, Sasanian Iran, or even India.[1]

But most importantly, the classical narrative leaves us with yet more serious and inexplicable problems, both with regard to the beginnings of Islamic science and with regard to its decline and eventual demise. In the case of beginnings, the classical narrative creates the impression that the birth of Islamic science took place during the early period of the Abbasid times, mainly during the latter part of the eighth century and the early part of the ninth, as a result of one or more of the following processes of transformation:

(1) Contact between the nascent Islamic civilization and the more ancient civilizations of Byzantium and Sasanian Iran is supposed to have taken place when the domain of Islamic civilization expanded outside the Arabian Peninsula and came to inherit the domains of those earlier civilizations or to share great geographic spans with them.[2] This "contact theory" had the distinct advantage of explaining the birth of Islamic science as a result of outside forces, a disposition already signaled by a particular reading of the classical Arabic sources. Those sources speak, for example, of the "ancient sciences" when they wished to describe the sciences that were brought into Islamic civilization from outside, or when they wished to contrast those sciences with the "Islamic sciences" (usually understood as the religious sciences that grew within the civilization). At times the two sciences are posited as being in direct opposition.

The downside of this theory is that it cannot furnish an explanation for the high quality of Greek scientific and philosophical texts that were translated into Arabic during this contact period of early Abbasid times when the contemporary surrounding cultures of the time had not been participating in the production of such texts for centuries before the advent of Islam.[3] In other words, the scientific and philosophical texts, usually designated by the term "ancient sciences" in the classical Arabic sources, contained material that was already written in the classical period of Greek civilization, and most of them were indeed produced before the third or the fourth century A.D. As far as we can tell, and as far as the sources demonstrate, no similar activities continued to take place in Byzantine[4] or Sasanian civilization that could have put those texts in circulation and thus made them readily available to the translators who worked in the extensive translation movement of early Abbasid times. When we examine that translation movement, we find translators such as Ḥunain b. Isḥāq (d. 873) searching for classical Greek scientific texts all over the old Byzantine domain, and sometimes failing to find what was needed.[5] Under such conditions, when books were not taught or used in wide circulation, how could contact have produced any positive and effective transfer of knowledge? The classical narrative has no convincing answer to such a straightforward question.

Besides, for scientific contacts to be successful it is only natural to assume that both cultures had to have been at similar levels of development so that ideas from one culture could easily find a home in the other.

(2) Those who were conscious of the downside of the contact theory, and of its failing to document contemporary scientists of Byzantium or Sasanian Iran who could have produced texts similar to the ones that were being sought by the translators of Abbasid times (that is, texts of the quality of ancient more classical Greek scientific and philosophical texts), thought they could avoid that pitfall by proposing another form of transfer that I shall call the *pocket* transmission theory.[6]

In this new theory, assumptions were made about the survival of ancient scientific and philosophical texts in a few cities in Byzantium or in the then-defunct Sasanian Empire. In those cities, classical Greek scientific texts were supposed to have been preserved. Antioch (the cradle of early Christianity), Ḥarrān (the site of many legends recorded in later Islamic sources), and Jundīshāpūr (where academies, hospitals, and observatories were supposed to have flourished) were all mentioned at one time or another as major repositories of ancient classical Greek texts.

But preserving second-century texts for hundreds of years, or even making new copies of them when there was need for them in Baghdad (as was done during the ninth century[7]), could not guarantee that there would be people who could understand these texts when they were being sought for translation,[8] during Abbasid times, about 700 years after they were written. Moreover, scientific and philosophical ideas usually flourish through open discussions. And it would be highly unlikely that enough such discussions were taking place between the fourth and the eighth century to affect another incoming culture. After all, there were some major reversals in scientific knowledge during that intervening period—for example, Cosmas Indicopleustes (c. 550 A.D.) proposed a flat Earth about 800 years after Eratosthenes measured Earth's circumference.[9] Knowing of the treatment of the mathematician Hypatia, who fell in between two competing powers of her time (the church and the state), and of her violent death at the hands of a mob of church followers who used her learning against her in the form of rumors in their political struggle, makes the kind of folk and popular science that was propagated by Cosmas more characteristic of Byzantine science than of the more sophisticated science of earlier classical Greek times. In that light it becomes unimaginable that any Byzantine scholar of that period could have produced anything of the sophistication of Ptolemy, Euclid, or Galen, or even fully understood what those giants had written.

Furthermore, neither in Antioch nor in Ḥarrān nor in Jundīshāpūr could one find a single scientist or philosopher of any importance who could have produced any work that could demonstrate his or her sophisticated understanding of the classical Greek scientific and philosophical texts, let alone match them in brilliance. Sure, one may find some references to such folk scientific ideas as names of stars, calendar approximations, or some astrological prognostications, of the type we see in the works of the Syriac scientists mentioned below, or even the works of Paulus Alexandrinus.[10] One may even find some elementary medical texts, or texts dealing with weather prognostication and star configurations, or even texts containing pharmacological material (mostly in the form of home remedies). But nothing of the caliber of the classical Greek scientific texts could be found.

Besides, how could it be possible for one or two cities in any empire to acquire and maintain a viable scientific tradition when there was no concrete evidence of such a flourishing tradition in any of those cities, nor was there any evidence that the rest of the cities of the empire could have produced anything of the sort? If the capital city could not have those sciences available, and if those who went through great hardships to study them (as had happened with Leon the Mathematician) were so poorly viewed by their own students, then how could those sciences be available at less important centers, so that they would exert any perceivable influence on a foreign culture that came in contact with them? If those pockets could exist for hundreds of years in such isolation, and still maintain a sophisticated degree of philosophical and scientific production similar to what was reached in the classical times before the third century A.D., that would be an unparalleled phenomenon that would require much documentation by the proponents of such a theory before it could be really accepted.

And yet there is some debatable evidence of sorts. In his account of the transmission of philosophy to the lands of Islam,[11] the philosopher al-Fārābī (d. 950) recounts the story of how philosophy was transmitted from Greece to Alexandria, and from there to Antioch, Ḥarrān, and Marw, and finally to Baghdad. But a close examination of that story (which became the basis of a famous article by Max Meyerhof, "Von Alexandrien nach Baghdad"[12]) makes one appreciate Paul Lemerle's remark about it: "Je ne suis pourtant pas certain qu'on puisse accepter sans retouche la séduisante construction de M. Meyerhof."[13] The story certainly seems to reveal more about Fārābī's desire to connect himself to the long philosophical line stretching back to Aristotle than about his desire to produce an accurate historical account of the actual transmission of philosophy from Greece to the Islamic civilization. This is corroborated by the fact that it is the same Fārābī, and in the same story, who recounts the persecution of the philosophers (and we should understand that as including scientists, since science, at the time, was really natural philosophy) at the hands of the Byzantine emperors as well as the Christian church. In it he only mentions the very brief respite from persecution that occurred during the very short rule of Flavius Claudius Julius (361–363). More pointedly, it was Fārābī too, who recounts, in the same story, the persecution of philosophy at the hands of Christianity (consistent with what we just mentioned of the fate of Hypatia and others). And in that regard, Fārābī asserts, in no ambiguous terms, that philosophy was finally freed only when it reached the lands of Islam.

If this were the case, and there is much evidence to corroborate the account of persecution as we have already seen, then how could classical

Greek philosophy maintain a rigorous tradition, in cities far apart, and at such times when the official policy of the state was to suppress that very same tradition, and when the only support that was ever given to philosophy was during a three-year reign of an emperor who was fought on every ground and was indeed called “the apostate”? With all those questions, and with this kind of evidence that is used for its support, one need not say anything more about the inability of this theory to explain the transmission of Greek science into Arabic.

(3) Then there are those who propose a more nuanced theory of transmission of the Greek philosophical sciences to Islamic civilization by postulating a transmission that went through the Syriac medium first. And this theory too has some evidence to support it. In this context people cite the works of the Syriac writers Paul the Persian (c. 550) and Sergius of Rasʿaina (d. 536), and the slightly later writers Severus Sebokht (c. 660) and George, Bishop of the Arabs (c. 724). The theory asserts that those people brought the Greek tradition into Syriac first, only to make it available for Arabic translations later on.

And all those Syriac authors produced works that could be described as scientific, with some degree of seriousness. But when those works are examined carefully, they turn out to be of the same quality as the ones that were produced in the larger Byzantine Empire; that is, they were elementary relative to the classical Greek texts. Paul’s work did not seem to extend beyond the elementary treatises on logic,[14] and Sergius did not apparently venture with his astronomical explorations much beyond the *Apotelesmatica* of Paulus Alexandrinus (c. 378), from which he adopted a very elementary approximative method for calculating the positions of the sun and the planets.[15] The method was so crude that it could nowhere be compared with the more exacting methods of Ptolemy’s *Almagest* and *Handy Tables.* The fact that Sergius knew of such august works of the classical Greek tradition is duly attested by his references to them, but only to say that they were to be sought only by those who needed higher precision. He seemed to have satisfied himself with the work of Paulus Alexandrinus.

The slightly more sophisticated works of Severus Sebokht (for example, his treatise on the use of the astrolabe[16]), and those of George, Bishop of the Arabs,[17] are not much closer to the classical Greek scientific texts, and in general they exhibit the more historically understandable standard of being of about the same quality as the contemporary Byzantine sources from which they seem to have derived their inspiration. And why should it be otherwise? Why should the poorer Byzantine subjects, as the Syriac-speaking subjects were, know more than the more sophisticated and much richer Byzantine overlords?

In fact we get echoes of this social class distinction, and the enmities that went with it, from the works of Severus Sebokht himself, who does not shy away from bragging against the Byzantine Greeks by asserting that his own ancestry extended all the way back to Babylonia, and that there were other nations, like the Indians, who could outsmart the Greeks in science.[18] He cites as evidence of the Indians' superiority their knowledge of the decimal system, with which, he says, "they calculate with nine figures only."[19]

All this evidence illustrates that the Syriac route of transmission, at least during pre-Islamic and early Islamic times, could not have been much more reliable than the contact or the pocket theory of transmission. And yet the rise of the more sophisticated Islamic scientific tradition in early Islamic times owes a great deal to the acquisition of the Greek scientific legacy and the direct translations of major classical Greek scientific and philosophical texts. How did this happen? The following chapter will, I hope, shed some light on this.

Having resorted to the three methods of transmission that are often mentioned by the proponents of the classical narrative, we find ourselves at a loss to explain how this transmission took place. This, to say nothing of the motivation of the early Abbasid caliphs for the acquisition of these ancient sciences, which had been already abandoned for about 700 years before those early Abbasids began to translate them. Why the sudden awakening? And why were the Abbasids so motivated toward the beginning of the ninth century to finance, patronize, and undertake such a major operation, or even make it "a regular state activity,"[20] as is often stressed by the classical narrative but rarely explained? It is hoped that the following chapter will shed some light on this subject too.

The early Abbasids' involvement in the activity of transmission remains to be explained, even if all those problems regarding the manner in which the "ancient sciences" were transmitted to the Islamic civilization were all resolved once and for all, and even if the classical narrative that generated them was abandoned. For there would still remain a second and more important problem: that of the timing of this transmission, which the classical narrative locates toward the beginning of the Abbasid times. Why at that time in particular and not during the earlier 100-year rule of the the Umayyads? What was so special about the Abbasids? Here the classical narrative offers three plausible explanations for that starting point, two of them corollaries of one another:

(1) It is very well known, as is repeatedly emphasized by the classical narrative, that the general character of the Abbasid dynasty allowed the ascendancy of the "Persian elements" of the Islamic empire. For, after all, the argument goes, the Abbasids rose in rebellion first in Transoxania, and they did so against the Umayyads, who were in turn characterized by the classical narrative that bases itself on many other classical Arabic sources as champions of the "Arab elements" of the empire. In fact one finds some echoes of such contentions in the classical Arabic sources themselves.

It is true that the Abbasids, who came to power with the swords of the central Asian troops, brought along with them clients who ruled on their behalf in the Transoxanian provinces, and thus depended greatly on the loyalty of those central Asian troops, many of whom were of Turkic and Persian origins. It is also true that the men who occupied the high positions of government, at least in the early Abbasid times, and at the ranks of viziers and the like, such as the members of the Barmakid family, were themselves of Persian descent. And despite the devastating demise of the Barmakids toward the beginning of the ninth century (when the whole family was simply wiped out from positions of power[21]) other Persian families such as the Nawbakhts simply replaced them in the high positions of government.

That the sources speak of Persians, Turks, and Arabs (among others) during the early Abbasid period indicates that these sources, from which the classical narrative derived its inspiration, began to reflect, at that particular time, the racial makeup of the people in power. That phenomenon itself must be explained rather than be stipulated in such essentialist terms, as the classical narrative seems to do with that particular historical setting.

In other words, and even if we privilege the classical narrative with some analytical power, then we still have to explain why the "Persian elements" of the Islamic empire would resort to translating Greek scientific and philosophical sources and not restrict themselves to translating Persian sources, for example. Dimitri Gutas, in his recent book *Greek Thought, Arabic Cul-*

ture,[22] offers a plausible explanation. Gutas refers to what he claims was the prevailing ideology of the time, reflected in a source that was quoted in the *Fihrist* of al-Nadīm (c. 987), and which asserted that all sciences began in Persia and that those sciences were translated into Greek at the time of Alexander's invasion of Persia, thus leaving the Persians deprived of their legacy after the cataclysmic devastation that befell them at the hands of Alexander. So when those Persians came to power, inexplicably only during Abbasid times and not before during Sasanian times when they were the full masters of the lands east of the Euphrates and sometimes even west of it, they awakened to that ancient legacy and decided to reclaim it. Thus, starting with al-Manṣūr, the second Abbasid caliph who enjoyed a relatively long reign, to al-Mahdī, and Hārūn al-Rashīd, and then of course to Al-Maʾmūn, who epitomized this trend, one caliph after the other doggedly persisted in reclaiming this Greek scientific heritage. They also patronized the more literary Persian translations, simply because there were no more sciences left in Persian after their abandonment from the time of Alexander's plunder.

This explanation fits well with the then-prevailing trend in the classical sources just mentioned, in which the "Persian elements" were made responsible for this large-scale Abbasid enterprise. It does not explain, however, the lack of real interest in such reclamation of original Persian sciences from the Greeks during the times of the Sasanians, when they were the masters of the domain, and in constant warfare with the Greeks. In fact, the same reports that speak of the reclamation of the Persian sciences from Greek during Abbasid times also speak of earlier Sasanian attempts to reclaim Persian sciences, but mainly from India and China, and from the Greeks only as an afterthought. These reclamation efforts remain unsubstantiated.[23]

Searching for evidence of the actual scientific texts that were produced or translated during Sasanian times, one could certainly find at least one astronomical work, the so-called *Zīj-i Shahriyār,* which was later translated from Persian into Arabic. And since the *Zīj* itself was composed during Sasanian times, this does indeed indicate an interest in scientific works in the Sasanian Empire. Unfortunately the *Zīj* is no longer extant. But from the few citations of it in later Arabic sources, it seems to have been more indebted to Indian astronomical sources than to Greek ones,[24] and thus this particular, almost unique, source does not attest to the interest in Sasanian Iran in reclaiming "their" Greek heritage. Rather it points in the other direction.

Other astrological texts, such as the *Anthologia* of Vettius Valens[25] and the

Carmen Astrologicum of Dorotheus Sidonius,[26] were indeed reclaimed from Greek into ancient Persian, and were later translated into Arabic during Abbasid times. But even those astrological texts can hardly be called a reclamation of the Greek sciences on the scale or sophistication in which they were reclaimed during Abbasid times. A look at the second of those texts and the fragments that have been quoted of the first reveals that they were mainly books of descriptive astrology and not the more sophisticated and demanding horoscopic astrology, which could be attained only after the translation of the more sophisticated texts such as Ptolemy's *Handy Tables*. Such tables would indeed enable one to cast a horoscope.

Furthermore, when one surveys the texts that were translated during the Abbasid times, one finds a major qualitative difference between the texts that were translated then and the texts that were translated before, either into Syriac or into Pahlevi. In the earlier times, such elementary, mainly descriptive texts were translated into the various languages. In the later Abbasid times, most of the books that were sought for translation were on the whole theoretical in nature and were much more sophisticated in content. In contrast, one finds in the later period such translations as the *Almagest* of Ptolemy, Euclid's *Elements,* the *Arithmetica* of Diophantus, the *Conics* of Apollonius, and the *Arithmetic* of Nicomachus, and also more descriptive yet analytically theoretical texts, such as the *Tetrabiblos* of Ptolemy. There is no record that even the *Tetrabiblos* was been translated into Syriac or Pahlevi in pre-Abbāsid times. The Syriac text that is designated as the *Tetrabiblos* at the Bibliothèque Nationale de France [Syr. 346, fols. 1–35] is in fact a paraphrase, and a poor one at that, and not a translation of the type that was done in the case of the more theoretical texts that were translated into Arabic during the Abbasid times. And yet we do not even know when this paraphrase was produced.

Therefore, when the classical narrative seeks the motivation for the translation activity in the dominance of the "Persian elements" in the Abbasid empire, and in their desire to reclaim what they thought was theirs of the Greek sciences, that explanation creates more difficulties than it resolves, for it remains completely silent about the lack of concrete evidence for such motivation at the time of the supreme Persian ascendancy during Sasanian times. Furthermore, the legend of the translation of Persian sciences into Greek at the time of Alexander is not such a reliable story that it could be used as an explanatory basis for the translation movement that took place during the early Abbasid times. In fact, the story itself is a part of the phenomenon of the translation movement itself and a feature of the intellectual life of early Abbasid times and not the explanatory cause of it. In all likelihood, the story was created after the facts and thus itself needs to be explained.

(2) Another motivation for the translation activity during early Abbasid times, which is often cited by proponents of the classical narrative, is the ascension of al-Maʾmūn to power in 813, and his reliance on the Muʿtazilite school of *Kalam* as a state theology. This particular caliph is often endowed with an interest in the philosophical sciences and a preoccupation with introducing the Muʿtazilite doctrines in the realm, so much so that he began to see dreams that justified his disposition. In one of those dreams he is supposed to have seen Aristotle himself,[27] and to have had the chance to interrogate the great master about the great ethical and philosophical issues of the day. He asked Aristotle, for example, "What is good?" Aristotle is supposed to have replied "That which is good in the mind." And when asked "What next?" Aristotle is supposed to have answered "That which is good in the law." When al-Maʾmūn persisted in asking "What next?" Aristotle is supposed to have added "That which is considered good by the people." But when he again asked "What next?" Aristotle stopped and said "There is no next." In another account, Aristotle is supposed to have continued to advise al-Maʾmūn to treat those "who advised him about gold like gold" (an apparent reference to alchemists), and then he is supposed to have said "and you should adhere to the oneness of God (*ʿalaika bi-l-tawḥīd*)." The last phrase is an obvious reference to the Muʿtazilite doctrine, as those people were called "the people of oneness" (*ahl al-tawḥīd*) on account of their insistence on God's oneness, which did not even allow the Qurʾan, God's speech, to have been co-existent with Him at the beginning of time.

(3) The third motivation is also associated with the Muʿtazilites and their connection with al-Maʾmūn, who made their doctrine official state doctrine. This policy was also followed by two of his successors and eventually led to a type of inquisition often referred to in the sources as the *miḥna* (testing/interrogation, inquisition),[28] hardly an enlightened open environment for scientific inquiry. In this *miḥna* people were supposed to declare that the Qurʾan was created in time, specifically in agreement with the Muʿtazilite

doctrine that insisted on God's oneness in the beginning. People who refused to adopt such a doctrine, including the great jurist Aḥmad b. Ḥanbal (d. 855), were put in jail.[29] This climate is supposed to have energized philosophical thinking during that period of Abbasid rule, or at least so the classical narrative goes, and thus it must have motivated the acquisition of the major Greek philosophical texts, and thus opened the doors for the vast translations that followed. In other words, the classical narrative asserts that once the doctrinal debates within Islamic society reached their peak to become part of state policy, the state must have encouraged the translations of all those philosophical and scientific texts in order to buttress its intellectual position.

This explanation could have been plausible had it been supported by the facts. In this regard, the historical sources tell us that the Muʿtazilite connection with the state was indeed very short-lived, and when the caliph al-Mutawakkil came to power (847 A.D.) he not only reversed the policies of al-Maʾmūn but went on to support the Muʿtazilite opponents, at this time called *ahl al-ḥadīth* (people of tradition—meaning people who sought legal justifications in the traditions of the prophet, and less so in human reasoning as the Muʿtazilites had done). And yet it was during the reign of this last caliph that the greatest amount of translations from Greek sources were ever accomplished and mostly by the prolific translator of the time, the famous Ḥunain ibn Isḥāq (d. 873), who worked as a physician at al-Mutwakkil's court. The books that were translated from Greek, mostly during the time of al-Mutawakkil, far outweigh those that were patronized by al-Maʾmūn. In fact I know of only one surviving book that is expressly designated as having been translated at the order of al-Maʾmūn, but I am not sure whether that designation was there on the book when it was first translated in 829 or whether it was added later by an owner or some other librarian trying to give its history.[30]

The classical sources do in fact speak of all sorts of scientific activities that were patronized by al-Maʾmūn, some apparently verifiably real such as the mission he sent to the desert of Sinjār to measure the length of one degree along the Earth's meridian,[31] and to conduct some astronomical observations. Other, perhaps more fanciful, stories such as the missions he sent to Constantinople to acquire Greek scientific manuscripts or Greek scientists speak to some interest this caliph may have had in such matters.[32] But it is never clear whether those activities were indeed ordered by al-Maʾmūn himself or by bureaucrats working in his administration. The role of the bureaucrats will become clearer in the next chapter. For now, the same historical sources, report that the later bureaucrats, who worked in al-Mutawwakil's administration, were themselves the ones who sponsored and paid for a great number of books to be translated. They also executed a great number of scientific and technological projects.[33] In fact I do not know of a single book that was translated for al-Mutawakkil himself, despite the great intellectual activities that took place during his reign, but I know of a great number of books that were translated for three brothers, known collectively as Banū Mūsā, who worked at his court, and sometimes at great risk. I shall have reason to return to this aspect of the translation movement in the following chapter when I explain the alternative narrative regarding the rise of science in early Islamic times. For now, I continue with the critique of the classical narrative.

Other Problems with the Classical Narrative

When it comes to details, the classical narrative cannot account for the very scientific facts that have been preserved either in the classical historical sources of the period or in the scientific texts themselves. For example, more than one historian tells us[34] that when the caliph al-Manṣūr wished to build the city of Baghdad, in 762 A.D., he assembled three astrologers and charged them with casting the horoscope for the future city. They were supposed to choose the time for the foundation so that no potentate would be killed in the city. The horoscope itself is preserved in the *Chronology* of Bīrūnī, and in several other sources. Most sources agree that the astrologers who were assigned that task included Nawbakht (a Persian astrologer who became the progenitor of the Nawbakht family of astrologers, which served caliphs for a whole century), Ibrāhīm al-Fazārī, and Māshāʾallāh al-Fārisī. Bīrūnī states explicitly that it was Nawbakht who determined the day for the foundation of the city to coincide with the propitious 23rd of July of that year.

If the ancient Greek sciences were supposed to have been brought into Arabic by the Persian-leaning elements of the Abbasid dynasty, even if we grant that this interest started with al-Manṣūr himself, and if we grant that they could recruit for the purpose of the horoscope the Persian astronomers Nawbakht and Māshāʾallāh, then who was this Ibrāhīm al-Fazārī, obviously an Arab from the tribe of Fazāra, who was also invited to join them, and where did he acquire the kind of advanced astronomical knowledge that he would have needed for casting such a horoscope at that early time in the Abbāsid reign? Where did his usual collaborator Yaʿqūb b. Ṭāriq learn his own astronomy so that he could produce, together with Fazārī, a translation of the Sanskrit *Sidhanta* (*al-Sindhind*), which was completed during the caliphate of al-Manṣūr (754–775 A.D.)?[35] Later sources always joined those two names together,[36] so it is sometimes difficult to determine who did what. For the purposes of the Baghdad horoscope, we may stipulate that Fazārī may have learned his craft in Persia. But the sources are silent on that, and we do not know much about the Persian astronomy of the time beyond the existence of the *Shariyār zīj* (which was quoted in later sources). Furthermore, the historical sources that connect the two assert that this very same Fazārī and/or Ibn Ṭāriq also wrote a theoretical astronomical work called *Tarkīb al-aflāk,* which seems to have been lost. The same Fazārī is also credited with the authorship of his own *zīj,* in which he used the "arab years" (*ʿalā sinīy al-ʿArab*).[37] Writing a theoretical astronomical text, transferring a *zīj* to a different calendar with a completely different intercalating scheme, and producing astronomical instruments such as astrolabes—as we are also told about these men—could not have been done by amateur astronomers. Who educated Fazārī and Ibn Ṭāriq in all these fields of astronomy? And even if we believe that the three astrologers also used the Persian *Zīj-i Shahriyār* for the purposes of the horoscope, we should also ask about another Arab, ʿAlī b. Ziyād al-Tamīmī, from the tribe of Tamīm, who was supposed to have translated this *zīj* into Arabic.[38] Who taught al-Tamīmī how to translate a *zīj,* and when he did so did he also transfer it into Arab years (as we are told Fazārī had done)?

All this evidence indicates that there was a class of people, who were already in place by the time the Abbasids took over from the Umayyad dynasty, who were competent enough to use sophisticated astronomical instruments, to cast horoscopes, to translate difficult astronomical texts, and to transfer their basic calenderical parameters, as well as to compose theoretical astronomical texts such as *Tarkīb al-aflāk*. Such activities could not have been accomplished by people who were just learning how to translate under the earliest Abbasids, as the classical narrative claims.

The situation gets more complicated, again on the level of details, when we look at the works that were produced about 75 years later by people like al-Ḥajjāj b. Maṭar (fl. ca. 830), who translated the two most sophisticated Greek scientific texts: Euclid's *Elements* and Ptolemy's *Almagest.* We know, for example, that al-Ḥajjāj finished his translation of the *Almagest* in the year 829, as is attested in the surviving copy now kept at the Library of Leiden University (Or. 680). And when we look at this translation we are immediately struck by two most startling phenomena: the language of the text is impeccably good Arabic, technical terms and all; and the Arabic translation even corrects the "mistakes" of the original Greek *Almagest.* Who taught al-Ḥajjāj the technical terms, and who taught him how to correct the mistakes of the *Almagest*? Neither of these questions is resolvable if we continue to believe the classical narrative that dates the beginning of the serious translations to the time of al-Maʾmūn (813–833). Early translations usually struggle with technical terminology, and usually do not go beyond the letter of the text and would never dare correct its mistakes, if they could understand the text in the first place.

Furthermore, we know that al-Ḥajjāj's translation of those scientific works was not the first. In fact, we are explicitly told by some sources that those two books were already translated under the patronage of Khālid al-Barmakī, the vizier of Harūn al-Rashīd (d. 809), and maybe by al-Ḥajjāj himself, and by others that they were translated during the time of al-Manṣūr (754–775).[39] But the farther back these translations are pushed, the more complicated the story becomes, for the question of the development of technical terminology would still persist and actually becomes even more difficult to answer. In any event, the text as it is now preserved in the 829 A.D. translation reveals a maturity that could not have come from one generation of translators. And thus we must allow for a longer period of translation so that more than one generation of translators would create enough output to produce technical terminology and teach the sophisticated mathematics and linguistic skills that were required to render the *Almagest,* the *Elements,* and similar books into the kind of coherent Arabic in which they are preserved.

During the same early period—that is, during the reign of al-Maʾmūn—we also witness the creation of the new discipline of algebra by Muḥammad b. Mūsā al-Khwārizmī (fl. ca. 830),[40] already in a mature format—treating, for example, the field of second-degree equations in its most general form. This happened before the translation of the work of Diophantus and other Greek sources. This does not mean that classical Greek sources, or for that matter ancient Babylonian sources, did not include algebraic problems, but the coinage of the new term for algebra (*al-jabr*), and the statement of the discipline in general as different from arithmetic,[41] required a kind of maturity that could not have come with the first generation of translators if we assume that translations began with the early Abbasid times as the classical narrative stipulates. Under such circumstances we are entitled to ask " Who taught al-Khwārizmī to do what he did?"

Similarly, a few years later, or even contemporaneously with Khwārizmī, we witness the creation of the discipline of *Hayʾa,* as in *ʿilm al-hayʾa,* which also did not have a Greek parallel. And that too could not have come about, as it did in the work of Qusṭā b. Lūqā (fl. ca. 850), which is still preserved in an Oxford Manuscript,[42] during the first generation of translations. Moreover, it is remarkable to note that Qusṭā himself, like other accomplished translators of his time, was already composing his own new scientific books, like his book of *Hayʾa* just mentioned, while he was still translating older, more common Greek scientific texts. Ḥunain did the same, and so did many others in this period. All that could not have come about at the hands of people who were translating for the first time, and needing to create the new technical terminology for their translations as well as their original compositions. In Quṣṭā b. Lūqā's Arabic translation of the *Arithmetica* of Diophantus there is a clear adoption of the algebraic language that was developed by the Arabic-writing algebraists of Quṣṭā's time, as is evident from Qusṭā's reference to the title of Diophantus's work as *ṣināʿat al-jabr* (Art of Algebra), a term that does not exist in Greek, and as was discussed by Rashed.[43] This kind of liberty with the translation clearly demonstrates the dynamic nature of the translation process of the early ninth century. Classical Greek scientific texts could easily be acclimatized within the current Arabic sciences of the time, thus transforming the translation process into a simultaneous creative process as well.

Furthermore, the remarkable advances that were made by Ḥabash al-Ḥāsib (fl. ca. 850) in the field of trigonometry and mathematical projection go far beyond what was known from the Indian and the Greek sources, and they could not have been accomplished by someone who was only a beneficiary of an early stage of translation. Ḥabash devised new ways of projecting planespheric astrolabes that preserved such fundamental features as directions to a specific point on the globe (in this case Mecca) and the distances to that point.[44] Such projections were not known from any earlier civilization, and their existence must give rise to questions regarding the possibility of the production of such results by people who would have been still struggling with the creation of new technical terms if they were contemporaries with the early generation of translators.

This generation of early mathematicians and astronomers must have also developed the Indian numeral system to such an extent that by the next century we note the first appearance of decimal fractions together with the decimal point in a manuscript completed in Damascus in 952 by Uqlīdisī. [45]

In sum, such results as the new algebra and trigonometry, the new *hayʾa* as well as the new methods of projection and the introduction of the Indian numerals and the development of decimal fractions, could not have all been produced at the same time with no previous works in those domains or in domains directly related to them. As a result, if the classical narrative insists on the beginning of the translation movement with the coming of the Abbasid Empire, and for reasons that were only motivated by the desire of the Abbasid caliphs, these questions will have to be answered before such claims can be accepted.[46]

Scientific Instruments and Observational Astronomy

In the field of scientific instrumentation, like the production of new types of mathematical projections that were created by Ḥabash as was already stated, those instruments could not have been created *ex nihilo,* as the classical narrative would want us to accept. In the case of Ḥabash's astrolabe, the new projections seemed to be related to the new Islamic requirements of facing Mecca while praying five times a day and performing a pilgrimage at least once in a lifetime. Yet such developments still required a remarkable sophistication in the application of geometric and trigonometric methods. Under normal circumstances, all these features would not usually come at once, but would rather progress slowly over time.

Similarly, the scientists of the same generation of Ḥajjāj, Khwārizmī, and Ḥabash and their colleagues seem to have also taken it upon themselves to double-check the observational results that were reported in the Greek and Indian sources from which they were trying to get their own inspiration. And there too, we find remarkable results already achieved in this very early period that indicate a much longer acquaintance with those fields. The observation that determined that the inclination of the ecliptic was not

23;51,20° (as was reported in Ptolemy's *Almagest*[47]) or 24°[48] (as was reported in the Indian sources), but that it was about 23;30° (as was determined during the first half of the ninth century[49]). That could not have come about as a result of the efforts of inexperienced astronomers who were conducting those observations for the first time. Such precision could only be achieved by mature astronomers who knew exactly what they were doing. That their value for the inclination is still in circulation today is a testament to the ingenuity of those ninth-century observers.

In the same vein, the determination of the new value for the precession parameter as 1°/66 years[50] or for the value of the solar equation, or the motion of the solar apogee—supposed to be fixed by Ptolemy—also could not have come about at the hands of inexperienced astronomers who were trying their hands on the discipline for the first time just as the major texts of that discipline were being translated. All these results must presuppose a longer acquaintance with such methods of observations, such new notions of precision, and such reflection on the function of instruments in determining new parameters. In sum, they must presuppose a much longer period of instruction and acquaintance with such concepts before the efforts would begin to yield such fruits.

Add to that the critique of the Greek observational as well as theoretical approaches to astronomy that were leveled by Muḥammad b. Mūsā b. Shākir[51] and his brothers Aḥmad and Ḥasan. Muḥammad, the first of the three brothers, would critique Ptolemy for his incoherent description of the physical operations among the celestial spheres, and would deem such motions physically impossible. And the three brothers together, or someone in their circle, would critique the method by which Ptolemy determined the position of the solar apogee.[52] These are not efforts that could happen all at once without previous experience with observational techniques, acquaintance with instruments, critical judgment of the sources of error, a developed concept of precision, and a well-thought-out connection between the observations and the theoretical results that were being achieved. People who were still struggling to translate texts for the first time could not normally achieve such maturity.

Problems with the End

Not only does the classical narrative fail to solve the problems I have been discussing so far, which are connected with the beginnings of scientific activities in Islamic civilization; it also fails to account for the questions raised during the later centuries. In particular, the decline of Islamic science, which was supposed to have been caused by the religious environment that was generated by Ghazālī's attack on the philosophers or by his introduction of the "instrumentalist" vision, does not seem to have taken place in reality. On the contrary, if we only look at the surviving scientific documents, we can clearly delineate a very flourishing activity in almost every scientific discipline in the centuries following Ghazālī. Whether it was in mechanics,with the works of Jazarī (1205)[53]; or in logic, mathematics, and astronomy, with the works of Athīr al-Dīn al-Abharī (c. 1240),[54] Muʾayyad al-Dīn al-ʿUrḍī (d. 1266),[55] Naṣīr al-Dīn al-Ṭūsī (d. 1274),[56] Quṭb al-Dīn al-Shīrāzī (d. 1311),[57] Ibn al-Shāṭir (d. 1375),[58] al-Qushjī (d. 1474),[59] and Shams al-Dīn al-Khafrī (d. 1550)[60]; or in optics, with the works of Kamāl al-Dīn al-Fārisī (d. 1320)[61]; or in Pharmacology, with the works of Ibn al-Baiṭār (d. 1248)[62]; or in medicine, with the works of Ibn al-Nafīs (d. 1288),[63] every one of those fields witnessed a genuine original and revolutionary production that took place well after the death of Ghazālī and his attack on the philosophers, and at times well inside the religious institutions.

It is not only that the classical narrative could not actually account for this prolific scientific production, at a time when the whole Islamic world was supposed to have been gripped by religious fervor, as the classical narrative dictates. Its failure went even further. It warped the production of those scientists when it deemed their results insignificant, and when it noted that those results were not translated into Latin during the medieval period, and thus concluded that the European Renaissance was achieved independently of what was taking place in these later centuries of the Islamic world. The works of this world that fell in between European medieval times and the time of the Renaissance could not be included in the general kind of history of science that the classical narrative could assimilate. As a result, the schism between what was happening in the Islamic world and what happened in the Latin West between the Middle Ages and the Renaissance grew deeper and deeper with the application of the classical narrative to the history of science. At the end the chasm was so deep that the relationship between those two worlds could no longer be understood, if its study was ever attempted.

With the European renaissance perceived as an independent European enterprise, and with the trajectory of scientific developments focusing on what took place in renaissance Europe, we also lost sight of the very exciting activities that took place at the borders between the Islamic and Byzantine civilizations. With the classical narrative emphasizing the importance of Arabic sources, only in as much as those sources could lead to the recovery of classical Greek antiquity—itself the object of the Renaissance as is commonly held—the outflow of scientific ideas from the lands of Islam to the Byzantine territories through the translations that went back from Arabic into Greek (Byzantine Greek at this time), starting at least as early as the tenth century and continuing till the fall of the Byzantine empire in the fifteenth century, still have not been accounted for. As a result, a whole chapter of scientific activities migrating across cultures remains almost completely lost to this day. Had it not been for the few maverick efforts of Neugebauer,[64] Pingree,[65] Tihon,[66] and their colleagues, and most recently Mavroudi,[67] no one would have known that there was such a rich chapter of scientific exchanges between Islam and Byzantium in a completely unexpected direction. This exchange, as it is becoming more and more apparent may have played a very important role in transmitting scientific ideas from Islamic civilization to the European renaissance, and thus must change the very image of the renaissance itself when it is fully accounted for.

Of the problems associated with the classical narrative, we must note that the insistence on the independence of the European renaissance from outside influences also keeps us from appreciating the role of such distinguished Renaissance scientists as Guillaume Postel (1510–1581), whose handwritten annotations on Arabic astronomical texts, still preserved in European libraries, must raise the question about the very nature of the astronomical activities of the European renaissance. When we look at some of the Arabic astronomical manuscripts that were owned by Postel and were annotated in his own hand, and remember that Postel may have very well used those same manuscripts to deliver his lectures in Latin at the institution that later became the Collège de France, we are then forced to ask "Whose science was Arabic science in Renaissance Europe?"[68] All these problems must be resolved, not only in order to understand the extent to which Islamic science was integral to the science of the Renaissance, but also in order to understand the very nature of the Renaissance science itself.

In the same vein, if we ignore, as the classical narrative urges us to do, the theoretical contacts between the land of Islam and Renaissance Europe, such as the transmission of mathematical theorems used in astronomical theories, then the sudden appearance of those theorems in Latin Renaissance texts will also remain unaccounted for and incomprehensible. We already know that astronomers of the Islamic world had used those very theorems for a few centuries. We shall have occasion to return to this very fertile area of research when we consider the relationship between Copernicus's mathematical astronomy and his Islamic predecessors.

The case of the discipline of astronomy in particular is very relevant here for yet another reason. For it was this discipline in specific that seems to have suffered the most as a result of the popularity and the hegemony of the classical narrative. On the one hand, we note a remarkable activity, of the highest order of mathematical and technical rigor, that kept on flourishing in the Islamic world after the death of Ghazālī, so much so that I have dubbed this post-Ghazālī period as the golden age of Islamic astronomy, and yet none of those results that were reached during that period had a chance of being considered by the proponents of the classical narrative as being worthy of attention, let alone consider their influence on Renaissance Europe. In fact, as we shall see later, some of the results achieved in this period were so badly understood by the very few orientalists who ventured to study them, that their significance was not understood properly, both to the disadvantage of the historian of Islamic science as well as the historian of Renaissance science.

For example, when the great orientalist Baron Carra De Vaux attempted to understand the most important chapter in the astronomical work of Naṣīr al-Dīn al-Ṭūsī, *al-tadhkira* (book II, chapter 11), in order to make the results of this chapter available to Paul Tannery for his classic *Recherches sur l'histoire de l'astronomie ancienne,*[69] De Vaux had this to say: "Le chapitre dont nous allons donner la traduction suffira peut-être à faire sentir ce que la science musulmane avait de faiblesse, de mesquinerie, quand elle voulait être originale."[70] He continued: "La portée de ce chapitre n'est donc pas très grande; il mérite neanmoins d'etre lu à titre de curiosité."[71] This was said of the chapter that was most relevant to the astronomy of Copernicus, who himself used the results that were already established in it by Ṭūsī to construct a very essential component of his own astronomy of the *De Revolutionibus*. As a result of the frame of mind that was generated by the classical narrative, the real significance of this chapter to the revolution against Ptolemaic astronomy, and to the work of Copernicus that was yet to come, is completely lost to the historian who insisted that no new results could have been produced after Ghazālī's attack on the philosophers.

Still in the field of astronomy, and to detail further the amount of damage done by the hegemony of the classical narrative in intellectual history, take the remarkable work of another orientalist, Francois Nau, who edited and translated the work of Bar Hebraeus (1286), *Livre de l'ascension de l'esprit sur la forme du ciel et de la terre.*[72] Without doubt, this is the most innovative work in Syriac. Composed around 1279, it was heavily influenced by the Arabic astronomical revolution that was taking place during the thirteenth century. While editing and translating that work, Nau could not understand the "strange things" (*sharbe noukroyoye,* choses étrangères) that were relevant to the "nature of the spheres of the moon"[73] when these things were in fact lists of objections to Ptolemaic astronomy of which even Bar Hebraeus was aware, although he was not a practicing astronomer. Similar terminology was used by Bar Hebraeus to describe the problem of the equant, which was more associated with the "upper" planets (Saturn, Jupiter, Mars, and Venus) in Ptolemy's astronomy.[74] These "strange" things that Bar Hebraeus was pointing to were in fact in the same tradition of objections against Ptolemaic astronomy and had already been listed and codified in Arabic sources from the ninth century on. They were most elaborately codified in the famous extant work of Ibn al-Haitham (d. 1049) called *al-Shukūk ʿalā Baṭlamyūs* (*Dubitationes in Ptolemaeum*).[75]

Furthermore, Nau could not have been aware of the interdependence between the text of Bar Hebraeus and the texts of his contemporaries Muʾayyad al-Dīn al-ʿUrḍī and Naṣīr al-Dīn al-Ṭūsī as well as others. The works of those Arabic-writing astronomers had not yet been studied by the time when Nau was writing, except for the one chapter of Ṭūsī's work which was translated by De Vaux and which had no parallel in the work of Bar Hebraeus. But most probably, those post-Ghazālī works were not studied because the proponents of the classical narrative did not deem them important enough since they came from the period during which no important works were supposed to have been written. This is a typical example of a self-fulfilling prophecy.

Similar things happened in the field of medicine. To name only one more instance of the damage the classical narrative has inflicted upon the post-Ghazālī texts, I draw attention to the work of the famous Ibn al-Nafīs of Damascus and Cairo, who dared check the work of the great Greek physician Galen and dared say that there was a medical problem in that work. Galen had stipulated that the blood was purified in the heart by being passed from the right ventricle to the left one through a passage between the two ventricles. Ibn al-Nafīs protested loudly, around the year 1241, that there was no such a passage between the two ventricles of the heart. He went on to say that the body of the heart at that point was solid and does not allow a visible passage as "most people had said," nor an invisible one, as was stated by Galen. After rejecting the authority of Galen, by only using the evidence that he must have seen with his own eyes, he went on to articulate the need for the blood to pass through the lungs before it could be cleaned and passed on to the left ventricle so that it could be pumped through the body again. Of course this finding appears later in the works of Michael Servetus (ca. 1553) and Realdo Colombo (ca. 1559),[76] to be further refined and re-articulated by Harvey in 1627 and become the famous pulmonary or lesser circulation of the blood. The important point I wish to make here is that Ibn al-Nafīs's objections went unnoticed by proponents of the classical narrative, because those proponents did not expect to find such original thought at such a late date in the post Ghazālī period. As a result those objections were deprived of being contextualized in their normal Islamic habitat where such similar medical and philosophical objections against Galen had already been raised before by such people as Abū Bakr al-Rāzī (d. 925) in his famous book *al-Shukūk ʿalā Jālīnūs* (Doubts contra Galen),[77] or against the astronomical works of Ptolemy as was done in the just-cited work of Ibn al-Haitham.

Arguments are still raging about the importance of Ibn al-Nafīs's findings and their relevance to the European scientists of the sixteenth and seventeenth centuries, all because the classical narrative had simply exercised such a hold on people's minds, and for so long, that it now seems to make it almost impossible to think outside its boundaries. This is the kind of damage that this classical narrative has already caused to our understanding of the post-Ghazālī texts, as well as the texts of the European Renaissance itself.