

CHAPTER 27

The Interplay of Science, Art and Literature in Islamic Societies before 1700

Sonja Brentjes

Rarely in the studies of the role and place of sciences in Islamic societies before 1700 is attention paid to their relation to the arts and literature. This is true at least of the historians of science as well as the general public. Art historians, on the other hand, have tried for some time now to come to terms with the mutual impact of sciences and arts in different Islamic societies, periods and genres. Kurt Weitzmann, Richard Ettinghausen, Ernst Grube and Eva Hoffman have claimed that the translation of scientific texts in the ninth and tenth centuries, mainly from the Greek, some probably from the Middle Persian too, had introduced Muslim scholars, patrons and readers in the Abbasid Empire to scientific illustrations.¹ Together with the diagrams and sketches, miniatures of authors, patrons, students, rural scenes, animals, plants, minerals and, possibly, constellations of stars were transmitted to the new cultural elites.

This broad range of illustrations and illuminations of medical, astronomical, astrological, mathematical or alchemical manuscripts also exerted, in the opinion of art historians, a profound impact on the developing art of the book in the Abbasid world. At the same time, there was an apparent exchange of motifs between illuminated manuscripts and the scientific imagery impressed on metal objects, ceramics, buildings and bridges. This is particularly true of the visual representation of zodiacal signs and animals of the Turko-Chinese calendar. Centres of these interactions between sciences and arts, until the arrival of the Mongols in the Islamic world, were the Abbasid capital and some towns in Northern Iraq, Khorasan in Northeastern Iran and Fatimid Egypt. The destruction that the Mongols brought to Central Asia, Iran, Iraq up to Syria and Anatolia cut deeply into the cultural, political and economic fabric of the Islamic world of the early thirteenth century.

When the dust of invasion and bloodshed settled and the Mongol Ilkhanids ruled Iran, Iraq and Anatolia for almost an entire century, a new and vigorous art scene emerged and various sciences flourished in the dynasty's courts at Maragha, Sultaniyya and Tabriz. Art historians see this period as the beginning of a new relationship between

arts and sciences. If sciences had provided in the previous period part of the patterns and ideas for illuminating literary works such as al-Hariri's (1054-1122) *Maqamat* (Séances), now it was the literary and historical works such as Firdawsi's (d. ca. 1026) *Shahname* (Book of Kings) or Rashid al-Din's (1247-1318) *Jami' al-Tavarikh* (The Sum of Histories) that drew the attention of art-loving patrons and their artists. Art historians argue that illuminating and illustrating scientific books fell behind due to their limited thematic scope available to the artist. The fact that scientific works had their own visual formats and scopes did not mean, however, that the relationship between arts and sciences withered away. Rather, the reverse is true. The various post-Ilkhanid dynasties' growing and multifarious patronage of the arts, literature and history also proved beneficial to the sciences. In fact, the arts, literature, history, geography, religion and the sciences found a symbiotic togetherness in splendid anthologies produced under the patronage of the Timurid prince Iskandar Sultan (executed in 1414) in his courts at Shiraz and Isfahan. Similar forms of a mutually enriching coexistence of arts and sciences can be found in the Safavid scientific, technological and educational manuscripts. The Mughals in Lahore, Delhi and Agra or the Qutbshahis in Golconda also patronised illuminated scientific manuscripts produced in their art workshops.

In addition to the fine arts, literature, especially poetry, became an important partner of the sciences. Scientific terms and themes were appropriated for literary purposes, while writers on scientific topics increasingly welcomed poetical forms. Lately, a historian of philosophy and Sufism, Nasrollah Pourjavady, has examined a great many poems and prose texts that use a specific literary device called *zaban-i hal* or the language of spiritual experience.² This language is used for body parts, heavenly objects, plants, animals and the symbols of social classes, such as the sword and the pen. Numerous Arabic and Persian poems present themselves as debates between protagonists whose ideas draw directly on the sciences – astronomy, astrology, medicine—and philosophy. The social sphere of these poems and prose texts was again the court.

Other poems were educational and served directly for transmitting scientific knowledge. In most cases, they provide introductions to various scientific disciplines, among them medicine, arithmetic, algebra, geometry and astronomy. They appear in a broad variety of poetic forms, among them the *Qasida*, the *Urjuza*, the *Nazm* and the *Mathnavi*. The *madrassa*, the hospital, the library and the marketplace constituted their social milieu, although some of them also were part of courtly life.

In the following sections, I shall introduce the reader to some examples of these manifold relationships between the arts, literature and the sciences.

1. ILLUMINATED SCIENTIFIC MANUSCRIPTS OF THE THIRTEENTH CENTURY

Illuminated scientific manuscripts produced in the thirteenth century belong to three categories. The first one is that of translations from the Greek into Arabic, mostly medical or pharmaceutical works, in particular Dioscurides' (first century CE) *De Materia Medica* and Pseudo-Galen's *Book of the Antidotes*. The second category is made up of texts composed on the basis of Greek scientific works translated into Arabic. Its main

representative is ‘Abd al-Rahman al-Sufi’s (903-986) *Kitab surat al-kawakib al-thabita* (Book of the Constellations of Fixed Stars; henceforth, Star Catalogue). The third category comprises texts newly designed by authors writing in Arabic in various regions of the Abbasid realm. It contains works on mechanics and automata, medicine, cosmography, geography, natural history and other scientific matters as well as subjects that invite astonishment and wonder. These works can either focus on a single discipline, such as Ibn al-Razzaz al-Jazari’s (twelfth/thirteenth century) *Kitab fi ma’rifat al-hiyal al-handasiyya* (Book of Knowledge of Ingenious Mechanical Devices), or embrace an encyclopaedic range of knowledge, such as the *Rasa’il ikhwan al-safa’* (Epistles of the Sincere Brethren) (tenth or eleventh century) or Zakariya’ al-Qazwini’s (1203-1283) *‘Aja’ib al-makhlūqat fi ghara’ib al-mawjudat* (Book of Marvels of Things Created and the Miraculous Aspects of Things Existing).

The basis of the content, and apparently also the visual repertoire of these manuscripts, had been laid in the earlier centuries when texts from pre-Islamic societies were translated from the Pahlavi, Greek, Syriac and Sanskrit into Arabic. These translations took place between the eighth and tenth centuries. They transformed the culture of the Abbasid Empire to such a degree that most of the later Islamic societies between al-Andalus and India profited from the scientific, philosophical and medical concepts, models, methods and values appropriated in those times. A variety of these translations and the new works composed in conjunction with them seem to have been illustrated as well as illuminated, as fragments found for instance in the first Islamic capital of Egypt, Fustat (today a part of Cairo), show. These fragments contain sketches and other drawings for subjects ranging from astronomy and astrology to magic and possibly zoology.³ The oldest extant scientific text carrying images is ‘Abd al-Rahman al-Sufi’s book on the constellations of stars. He dedicated it to his patron ‘Adud al-Dawla (r. 936-983), the Buyid amir who ruled the Abbasid Empire for the larger part of the tenth century. The first preserved copy of this work is dated to the beginning of the eleventh century (1009-1010) and is housed today at the Bodleian Library in Oxford. It turned out to be one of the most frequently copied illuminated scientific texts in Islamic societies. Another richly illuminated book has for its contents geography, cartography, travel and commerce – the so-called *Book of Curiosities*, discovered only recently and also housed now at the Bodleian Library.⁴ The extant copy in all likelihood traces to the twelfth century, its original having probably been written approximately a hundred years earlier.

In the thirteenth century, Baghdad, Mosul, Diyar Bakr and possibly Aleppo were centres of scientific knowledge as well as artistic production. It was at these places that the copies of Dioskurides’ *De Materia Medica*, Pseudo-Galen’s *Book of the Antidotes*, ‘Abd al-Rahman al-Sufi’s *Star Catalogue* or Zakariya’ al-Qazwini’s *Marvels of Things Created* were carefully illustrated with black and red drawings of stellar constellations, small-scale coloured images of animals, plants and supernatural beings, and with richly coloured frontispieces. Other thirteenth-century illuminated copies of scientific manuscripts were produced in Iran and Northern Africa, as shown by those of ‘Abd al-Rahman al-Sufi’s *Star Catalogue*. To the late twelfth century (1193) also dates the first extant copy of Abu Ishaq al-Istakhri’s exposition of a set of twenty-two maps (one world

map and twenty-one regional maps) put together in the tenth century, preserved today in Gotha's Research Library.



Image 1: Dioscurides, Carvi (BnF, Arabe4947, f63v; 12th c). Courtesy Bibliothèque nationale de France, Paris.

The images of these manuscripts draw on a broad repertoire of visual traditions. The first set of traditions comes from ancient Greek and Roman secular literature such as Marcus Terentius Varro's (116-27 BCE) *Hebdomades* or illuminated scientific manuscripts.⁵ A sixth-century illuminated Byzantine codex made for Princess Juliana Anicia was, at one point of time, available to Arabic speaking readers—one of whom annotated its various images of plants. These images in the Arabic copy of 1229, particularly that of the grapevine, have been repeatedly praised for their naturalism and parallelism with ancient Greek paintings. The second set of traditions comes from the illuminated Gospels and other Christian literature produced in Byzantium, Egypt, Syria and Northern Iraq. The pictorial representation of Jesus Christ and the evangelists worked with the earlier secular models of author portraits and single images of famous men. The illuminators of Arabic medical manuscripts of the thirteenth century modified and rearranged the individual elements from these secular and Christian visual traditions

and combined them with motifs from their immediate environment. The so-called author portraits in the 1229-copy of Dioskurides' work, extant today in Topkapı Sarayı Museum, are an example of the artists' virtuosity. Dedicated to a ruler of Northern Iraq, parts of Syria and Anatolia, the double frontispiece shows Dioskurides on the one folio and two students on the opposite folio. Numerous components of Dioskurides' portrait remind the viewer of Byzantine and Coptic pictures of Christ and the evangelists. The setting of the students reflects the Fatimid Christian book art. In contrast to Dioskurides, the students are transformed into Muslims. Hoffman insightfully interprets this difference of visual adaptation and transformation as a characteristic of the illustrated text. It was meant to remind the viewer of the text's origin in the ancient Greek intellectual culture and its appropriation by Islamic intellectual elites and courtly circles.⁶

The *Mukhtar al-hikam wa-mahasin al-kalim* (The Choicest Maxims and Best Sayings) by the Fatimid prince Mubashshir b. Fatik (eleventh century) represents another genre of intellectual enterprise, the collection of philosophical sayings of wise men. The prince had planned to add images to his text. Today, however, only one of the extant copies of this work is found illuminated. It is housed in Topkapı Sarayı Museum. It links the illuminated scientific manuscripts of the thirteenth century to a specific genre of historical literature, viz. biographical dictionaries. Abu Nasr al-Farabi (d. 950), a leading Muslim philosopher who discussed the different categories of knowledge available at his time in his society, saw the arts and biographical literature as closely intertwined spheres providing relish and entertainment.⁷ In this perspective, Hoffman sees the author portrait as 'a visual companion and counterpart to the literary biography.'⁸ Kerner, while placing biographical dictionaries in the realm of *adab*, comes to a similar inference on the two illustrated copies of Pseudo-Galen's *Book of the Antidotes* extant respectively in the Bibliothèque nationale de France in Paris (dated 1199) and the National Library of Austria in Vienna (undated, possibly of 1270).⁹

Two other sets of visual traditions adopted and adapted by the artists who illuminated thirteenth-century scientific manuscripts stem from pre-Islamic Iranian and Turkish peoples. They link the author portraits of medical and astronomical manuscripts to author as well as ruler portraits attached to literary works like al-Hariri's *Maqamat* or Abu l-Faraj al-Isfahani's (897-967) *Kitab al-Aghani* (Book of Songs). Courtly patronage linked the different textual genres and brought about the flow of artistic repertoires. The ruler portrayed in a copy of the latter book made in Mosul between 1216 and 1220 was the former Zengid Atabeg Badr al-Din Lu'lu' (r. 1211-1257). Badr al-Din was an Armenian who had been converted to Islam. His portrait shows him and his attendants as Seljuq Turks. The iconography of the portrait also carries reminiscences of pre-Islamic Iranian ruler portraits found on Sasanian silver plates and rock reliefs. Seljuq types and motifs are also found in copies of Sufi's *Star Catalogue*, as Raby has claimed for a fragmentary version preserved at the British Library in London.¹⁰ While most of the copies of Sufi's *Star Catalogue* show the figures in linear ink drawings, a few, among them this fragment, contain colourfully painted images. This shift in visual style may reflect the impact of Seljuq figurative art on other artistic and intellectual domains and its preference for block colours. It also represents a trend in illuminated scientific manuscripts away from the primarily didactic function of the image and towards the aesthetics of relish and entertainment.¹¹



Image 2: Pseudo-Galen, *Kitab al-Diryaq*, Frontispiece (ÖNB, Vienna, A.N. 10).
 Courtesy Österreichische Nationalbibliothek, Vienna.

An additional visual inspiration came from Buddhist Central Asia, as Brend has argued for Virgo, Perseus, Centaurus, Sagittarius and Andromeda in the oldest extant Sufi manuscript after comparing these drawings with a Bodhisattva from the eighth century and his two companions, an Avalokite vara and a Viripākṣa, both ninth-century images.¹² She has also pointed to Sasanian as well as Chinese elements in the depiction of Sagittarius and Andromeda.¹³ Analysing the inks of the paintings and the texts, Brend has shown that al-Sufi's son Husayn, named in the colophon as the scribe and illustrator of the manuscript, began the drawings according to the ancient pictorial model. However, he did not finish the work. Another painter took over and incorporated the Central Asian motifs.¹⁴ As a result, the appearance of the stellar constellations changed. In Antiquity, the stellar constellations personified ancient Greek mythological beings such as the hybrid horseman Centaurus, the water bearer Aquarius or the beautiful maiden

Andromeda sacrificed to a sea monster, and her saviour Perseus. The new pictorial programme introduced from the east comprises royal figures, men and women, in their fineries wearing crowns and jewels and sitting occasionally on thrones accompanied by servants and warriors.



Image 3: 'Abd al-Rahman Sufi, Star Catalogue, Andromeda (BnF, Arabe 2489, f68; 665h/1266-7). Courtesy Bibliothèque nationale de France, Paris.

This so-called princely cycle of astronomical literature found its counterpart in astrological representations of the zodiac and planets, whether as paintings in books such as copies of Abu Ma'shar's (787-886) *Kitab al-mawalid* (Book of the Nativities), or as decorations on metal work, *madrasas*, fortresses or bridges. Here, different alterations occurred such as the transformation of Virgo into a man and of Gemini into women, of Saturn into a six-armed seated male figure holding different symbols in his hands or of the horsetail of Sagittarius' lower body into a dragon and of the lower body itself into a leopard or a tiger. The richness of the astrological pictorial repertoire allowed artists manifold combinations. Over time, some of these changes were accepted across different Islamic societies, while others remained local and rare.

2. TIMURID APPROACHES TO THE ARTS AND SCIENCES

A major area of Timurid courtly patronage for the sciences was the copying and illustrating of scientific treatises in courtly *kitabkhane*s or workshops for illustrated and illuminated manuscripts. The connection between the arts and sciences was not limited, as it was often believed, to the occult and the popular such as magical bowls or miraculous illustrations. Neither was it stereotypic and conventional. Illuminated scientific works profited from the innovative changes that took place in the arts, from the new views on which scholarly disciplines should be sponsored by princely and other courtly patrons, and from an opening of disciplines – ones which previously had pursued rather austere modes of the visual – to artistic illustration. Splendid examples are a copy of the astronomical handbook compiled at Ulugh Beg's (r. 1409-1449) court in Samarkand with his personal participation, and illustrated for his library, and the excellent colour images of the stellar constellations in 'Abd al-Rahman al-Sufi's *Star Catalogue*, also produced for Ulugh Beg's library.¹⁵



Image 4: 'Abd al-Rahman Sufi, *Star Catalogue*, Centaurus with the Wolf (BnF, Arabe 5036, f238a, 1430-40). Courtesy Bibliothèque nationale de France, Paris.

At the beginning, the manuscript is adorned with a medallion, a *Shamse*. It carries the following dedication:

*For the treasury of the greatest and most learned sultan,
The master who has power over the life of the greatest sultans of the world,
The renewer of the sciences of the ancients,
The propagator of justice on earth,
The protector of kingship and of the world,
Ologh Beyg-e Gurkan,
May God make eternal his kingdom and his reign.*¹⁶

Ulugh Beg is often seen not only as the most educated and scientifically minded among the Timurid rulers and princes, but also as the only person of that kind in the entire dynasty and the last prince supporting mathematics and astronomy. To a certain extent, this evaluation is derived from the reports of Timurid historians and artists who focused primarily on the military prowess of the princes, their calligraphic and poetic skills and their physical beauty.¹⁷ They only emphasized the sciences when reporting on Ulugh Beg:

His late Highness Ulughbeg Kürägän was a learned, just, victorious and high-minded king. He attained an exalted degree [of knowledge] in astronomy and was quite adept at understanding poetry. During his reign scientists were given the greatest respect, and in his time the learned reached exalted heights. In geometry he pointed out the subtlest things, and in cosmography he unlocked the secrets of the *Almagest*. The learned and wise are agreed that in the history of Islam—nay from the time of Alexander until this moment—there has never reigned a king so wise and learned as Ulughbeg Kürägän.¹⁸

However, as art historians have shown, a closer study of the extant manuscripts produced at and for the Timurid courts yields a different picture. Historical, geographical, cosmographical, astronomical, astrological, mathematical, medical and alchemical subjects found the attention of various Timurid princes and were splendidly illuminated or illustrated in their art workshops. Such scientific luxury books, being part of the highly elaborate ritual of bestowing gifts, served Timurid ceremonials of the display of power and confirmation of loyalties. They were significant elements of Timurid cultural policies for establishing and maintaining dynastic as well as individual legitimacy as rulers within the realm of Timurid power. Astronomical, astrological and mathematical knowledge was essential for decision-making in regard to military campaigns, princely weddings and the erection of monumental religious and secular buildings. Illuminated and illustrated scientific texts had an important place in the highly successful Timurid efforts to set up their empire as the leading centre of culture in the entire Islamic world, as indeed the integration of such texts into Timurid anthologies of literature, art, history, geography, religion and sciences show. The choice of texts and authors included in such anthologies seems to have had a motivation similar

to that behind the choice of pictorial models for the miniatures illuminating the non-scientific themes. Classical texts by Euclid and Ptolemy, newly edited in the Ilkhanid period, are part of these Timurid collections. Much appreciated were scientific works produced at Ilkhanid courts, such as the *Ilkhanid Tables* compiled by a team of scholars at the court in Maragha under the leadership of Nasir al-Din Tusi (1206-1272). Furthermore, the anthologies include treatises by scholars working for the Timurid princes themselves, like Ghiyath al-Din Jamshid Kashi (d. 1429), or their immediate predecessors whom Timur had defeated, such as the Muzaffarids (1327-1393). The most extensive and copiously illustrated set of such collections of literary, historical, geographical, religious and scientific treatises are those produced for Jalal al-Din Iskandar Sultan, the Timurid ruler of Shiraz and Isfahan from 1409 to 1414.¹⁹ The following table gives a survey of the scientific texts included in these anthologies.

TABLE 1: ILLUSTRATED SCIENTIFIC TEXTS IN ANTHOLOGIES
PRODUCED FOR ISKANDAR SULTAN

Astrology	Astronomy	Mathematics	Geography	Veterinary / Medicine/ Medicine/ Alchemy/ Mineralogy
'Ala' al-Din 'Ali Shah b. M. b. Qasim Khwarizmi Bukhari, Ahkam al-a'wam Shah Mardin b. a. l-Khayr Razi, Rawzat al- munajji-min, dated Dhu 'l-Hijja 17, 813/April 12, 1411 'Ali b. M. Al-Sharif al- Bakri, Burhan al- kifayah Mawlud-i Humayun ve-Taqvim, Horoscope of Iskandar	Nasir al- Din Tusi, Zij-i Ilkhani	Euclid's Elements, extract	World map	Fi 'ilm al-baytara
	Ptolemy, Almajest, lost?	Jadval-i Sittin	Map/image Pilgrims at the Ka'ba	Kitab-i Bazat, dated Safar 10, 814/May 25, 1411
			Tuhfat al- ghara'ib (?)	Isma'il b. Hasan Jurjani, Aghraḏ-i □ libb[iyya] □ an'at-i Iksir

Sultan, Dhu l-Hijja 22, 813/ April 18, 1411 'Abd al- Jabbar Khujandi, Madkhal-i Manzum Tahawil sinin wa-tawalid Ahkam Abu Ma'shar, text is lost	Abu Bakr al-Razi, Risala dar 'ilm-i ikhsir Risala dar iksir Javahir-nama
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The conscious integration of sciences into arts and literature is not merely made visible by addition of the scientific texts listed above to Abu Muhammad Ilyas b. Yusuf b. Zakī Mu'ayyad's, known as Nizami, (ca. 1141-1209) *Khamsa*, Farid al-Din Attar's (ca. 1142-ca. 1220) *Mantiq al-Tayr* and *Ilahi-nameh* and numerous *ghazals*, *qasidas* and *mathnavis* by famous as well as not so famous Persian poets of the past and the present. The decoration of the pages on which these scientific texts were written down also links them—by way of rich ornamental motifs, animals, dragons, Chinese-style bands and clouds, scenes from Nizami's *Khamsa* and cartouches with Iskandar Sultan's name, titles and lines of poetry—ostensibly to the other genres of knowledge and to Timurid courtly patronage for the arts.²⁰

A preface to a lost text preserved by the astrologer and court historian of Shahrukh (r. 1405-1447) and his son Ibrahim Sultan (r. 1415-1435), Sharaf al-Din 'Ali Yazdi (d. 1454), bespeaks Iskandar Sultan's desire to present himself not only as a valiant warrior, patron of Persian and Chaghatay poetry and an eager disputant of metaphysical questions of reason and love; he also wished to be seen as a prince of the sciences. He described his studies as having started from *'ilm al-tawhid* (the science of unity = *kalam*), proceeding to *'ilm al-huruf* (the science of letters), *'ilm al-nujum* (astrology) and its theoretical basis, *'ilm al-hay'a* (mathematical cosmography), the science of planetary theory and mathematical geography:

Thus speaks the servant of God, the Exalted and the Master who commands there his servants, Iskandar, son of 'Umar Shaykh—may God pardon them both and be satisfied with them. . . . In addition to upholding the rules of law and fairness and to accomplishing the duties of justice and solicitude towards his subjects—'because one hour of good deeds is equivalent to seventy years [of life]'—he spent the wealth of his time and the quintessence of the duration and the moment for acquiring the certain sciences and things of knowledge and for accumulating the veritable virtues and perfections that are the capital of eternal beatitude and the ornament of perpetual fortune. . . . Guided by the sovereign favour and privileged by Divine guidance—. . .—he became in a short time informed and instructed in the sum of sciences, the rational as well as the revealed ones, the fundamental as well the derived



Image 5: Anthology for Iskandar Sultan, Cancer and Lion, at the margin: Majnun in the desert with animals (© British Library Board. All Rights Reserved. Add 27261, f 539, 1410-11).

ones. He pushed the verification of the discussions and goals of all of [these sciences] forward to a degree that the gifted and masterful [students] of this art had not yet achieved. In each of these sciences he discovered marvellous questions and astonishing issues according to the expression, ‘the masters of power are [ever] inspired’, as well as delicate finesses; and all this thanks to God’s grace which He dispenses on whom He wishes.

...

Hence, with a full appetite and sincere intention, the author began at first with *‘ilm al-tawhid* (the science of unity = kalam) and the harvest of ancient saints and masters,—may God be satisfied with them—, who all gave proofs according to their nature and their perceptive senses and carried forward valuable things. He profited orally from the results of the leavened spirit of this century’s greats—may God multiply their numbers and make them

perpetual—in their company and also from the course of their studies in their treatises and writings. He benefited in an abounding measure and wholly from the subtleties of *‘ilm al-huruf* (the science of the letters) the manifestation of which is one of the particularities of the august time of the Seal [of the prophets]. . . .

After this, having paid attention to the technical outlay of the scholars, he was informed about and familiarized with the history of each group of cultivated people, literati, transmitters of the sayings of the prophets, the legal scholars, the theologians, the philosophers, the mathematicians, the masters of the disciplines according to their different persuasions. After *‘ilm al-tawhid*, which is the essential goal and the veritable end, no science is more important and profitable than *‘ilm al-nujum* (astrology), because the [different] classes of human beings, humble and grand, in particular the governors and leaders of high rank, the sultans and the all-powerful sovereigns, are in need of knowing all that exists in absolute terms and acquire experience in and of the truthfulness of the proofs and justifications of what is said to happen. That is why he devoted himself to acquiring and sometimes perfecting this eminent art. He occupied himself with *‘ilm-i hay’a* which is the foundation and the basis of this noble science. Then he dedicated himself to establishing astronomical tables, the means of extracting ephemerides and horoscopes from their revolutions, derivations and developments. He proceeded to extract from them the astrological rules and results that are the fruit and the product of all [astronomy].

He brought together most of the writings and works which the ancients and the moderns in this science knew, but he did not find among them the work that sums up everything and allows the researcher to dispense with the others. Hence he composed the present complete work including all the important aspects of these sciences. He gave it the title *Jami’-i sultani* (The Princely Sum) though it did not live up to the ambition of his plan, because it was compiled by improvising while the author was travelling. The *Zij-i Ilkhani*, being the most correct, the most worthy of trust and the best of the astronomical tables, was made in the practical part [of the Princely Sum] the basis and the pillar. Because its author (Tusi) wrote it in an elegant style and because it is very difficult, [Iskandar] made every operation clear and evident by giving a corresponding and conforming example. Since cosmography is the first among these parts, it was presented at the beginning of the work. Its substance was summarized in twenty chapters.²¹

If this text in principle portrays Iskandar Sultan’s interests correctly, then Iskandar’s involvement with the sciences went beyond mere introductory education. It brought together the theoretical part of the religious disciplines, interestingly named by a term referring to Mu’tazili *kalam*, with a kind of occult mathematical discipline, that is, *‘ilm al-huruf*. This discipline had strong links to alchemy, Sufism and political rebellion, the latter being particularly virulent in Iran. Added to these two disciplines are astrology, astronomical handbooks and the theory of planetary models – one of the strongholds of

theoretical science in Islamic societies. The author of the preface justifies this addition by the political relevance of the predictions made by astrologers.

Although Iskandar Sultan probably was not as gifted a mathematician and astronomer as his cousin Ulugh Beg, he obviously pursued a similar kind of scholarly project. Iskandar's explicit placement of this project within the realm of cooperation with religious scholars as well as the politics of sultans and governors, suggests that we should see Ulugh Beg's creation of an observatory, of a new set of astronomical tables and of a *madrassa* devoted to the study of mathematics and astronomy shaped by comparable political and cultural considerations. The efforts of these two and other Timurid princes in the domains of arts, literature, sciences and architecture succeeded in establishing the major Timurid towns as cultural centres of the Islamic world. These Timurid models were imitated and transformed by their contemporaries and successors.

3. SAFAVID COURTLY ART AND ASTRONOMY

In its choice of topics, styles and practices, Safavid art followed the Timurid patterns. Hence it comes as no surprise that among the illuminated scientific texts extant from the art workshops of the Safavid courts, astronomical texts were seen as a worthy terrain for artistic endeavours. The most highly appreciated astronomical work for illumination was the by now canonical *Star Catalogue* of 'Abd al-Rahman Sufi. There were at least seven copies of this work, illustrated by Safavid artists of the sixteenth, seventeenth and perhaps even early eighteenth centuries, found in the libraries of Paris, St. Petersburg, New York, Cairo and Tehran. Some of these manuscripts are undoubtedly the work of court painters, such as the ones in New York and Cairo. They contain wonderfully painted images of Safavid women and men in richly coloured dresses and immortalized as ideal beauties. These images adorn a Persian translation of Sufi's Arabic text made in 1630/1631 at the command of the Safavid general and governor of the province of Mashhad, the Georgian convert Manuchihr Khan (d. 1636). The translator into Persian was Manuchihr's court astrologer, Hasan b. Sa'd Qa'ini. The artist who is mentioned in the preface to one of the two extant manuscripts of this translation is Malik Husayn Isfahani. He worked on the paintings from 1630 to 1633. In the view of some art historians, he was the only painter who illuminated the text, while others have argued that his son Muhammad 'Ali too collaborated in the work and that perhaps others were also involved.²² For a number of people to work together on one manuscript, even on one miniature, was not exceptional although Adamova has argued that apparent differences in style in the case of Timurid miniatures in literary and historical works do not necessarily mean that different painters were involved. The highly ideological approach of the Timurid art patronage—that expressed the claims to the legitimacy of the dynasty as heirs to Genghiz Khan and his family, through a systematic acquisition of historical, astronomical, geographical and other works by scholars linked to Ilkhanid rulers and their viziers—stimulated the copying of Ilkhanid paintings, their gradual variation and their complementary succession by innovative motifs and styles as a sought-after painting practice.²³ Adamova's ideas have not been applied yet to the study of illuminated scientific manuscripts of the Safavid period.

Farhad has highlighted the artistic innovations that characterise the two manuscripts of the Persian version of Sufi's *Star Catalogue* made for Manuchihr. She stressed the new pictorial style in a scientific manuscript, the unusually large format of the illustrations and their refined drawing and painting techniques.²⁴ As opposed to other art historians who saw in the beautiful paintings of these two manuscripts an extension of the style of one of the most celebrated Safavid court painters, Reza 'Abbasi (d. 1635), who worked for Shah 'Abbas I in Isfahan, Farhad sees the miniatures of these manuscripts as an expression of Manuchihr's desire for establishing himself as a successful patron of the courtly arts and reinforcing in this way his Persian and Muslim identity.²⁵ Choosing a scientific book may have been a less contentious choice for such innovative enterprise than a book of royal history such as the *Shahnameh* or a highly appreciated work of literature like Nizami's *Khamsa*. The political and cultural ambitions of the patron are underscored by the complex threads by which his royal lord and governor is linked with one of the heavenly constellations. In the New York manuscript, Sagittarius is portrayed with a highly individualised face that is believed to resemble Manuchihr.²⁶

The choice of this particular constellation may have been linked to the governor's birthday as well as to the month in which Shah 'Abbas I transformed Isfahan into his official capital.²⁷ Other components of the work such as Qa'ini's preface stressing his own innovative correction to the stellar coordinates, on the basis of Tusi's *Ilkhanid Tables*, and Ulugh Beg's *Zij-i jadid-i sultani* (The New Princely Astronomical Handbook) support this interpretation of the confluence of science and art in these two manuscripts of Sufi's *Star Catalogue*.

Sufi's *Star Catalogue* did not remain the only astronomical book deemed worthy of high quality artistic embellishment. For the first time, a text on theoretical astronomy, Qutb al-Din Shirazi's (1236-1311) *al-Tuhfa al-Shahiyya* (The Royal Gift), written in 1285 in Sivas for Taj al-Din Mu'tazz b. Tahir, the vizier of Amir-Shah Muhammad b. Sadr al-Sa'id (thirteenth century), was adorned with figurative paintings. The images are borrowed from Sufi's *Star Catalogue* and include Andromeda, alone and with Cetus, Boötes, Auriga and Hercules. They are joined to a model of Mercury, a visualization of the relative positions of the poles of various orbs, a parallax diagram, and a diagram for a specific spherical triangle.²⁸ The style of the painting, while less copious than that of the miniatures in Manuchihr's manuscripts, resembles strongly the painting style of Reza 'Abbasi. Thus, the ink drawings were ascribed to a student of this great painter.²⁹ It may not have been an accident that this work and this author were chosen for the application of artistic skills acquired in the entourage of the Safavid court at Isfahan. The author was one of Nasir al-Din Tusi's brightest students and had worked with him for years at the Ilkhanid court in Maragha. The work was, as its name says, written for a prince, although not one of the Ilkhanids but a local ruler in Anatolia. Hence, bringing the style of the Safavid royal master painter together with a highly respected theoretical text on the heavens seen as immutable and indestructible, written for a prince by a leading scientist of the Ilkhanid period, may have held a strong attraction for the Safavid patron of this undated and unsigned manuscript.

4. OTTOMAN MAPS AS MINIATURES

Most extant maps in Arabic, Persian or Turkish manuscripts are works of scribes who copied for a living or for their own education. They were often not fully interested in spending much time for a careful, neat execution of the intricacies of political, cultural or physical geography on a piece of paper. But this does not mean that no map was finely done, although not all carefully drawn maps were also works of art. Maps often consisted merely of a circle or a semicircle with contours of the oceans, small circles for major lakes, squares and rectangles for provinces and triangles or semi-ovals for mountains. This method did not provide for a lot of possibilities for the display of artistic virtuosity. Nonetheless, some of the geographical manuscripts executed for the courts of Iran or Anatolia presuppose in their colours, their variations and combinations of the basic geometrical forms, and occasionally in their allusions to or even open quotations from miniature paintings, the patron's expectation that even a highly symbolic representation of the world could and should be a work of art. They demonstrate the painter's effort to achieve this lofty goal. Some examples are: the world map made in 1411 for the Timurid prince Iskandar Sultan, preserved in the library of Topkapı Sarayı Museum; the maps of a manuscript of Ibn Hawqal's *Surat al-ard* (Image of the Earth) made for an unnamed ruler of Iran, found in the Malik Library in Tehran; or the maps in a Persian version of al-Istakhri's geography, but ascribed to Nasir al-Din Tusi, held by the Austrian National Library in Vienna.³⁰

Among the various dynasties whose princes showed a taste for nicely executed maps, the Ottomans take up the highest rank. Partly as a remembrance of their glorious deeds as military campaigners, partly as the elements of a cultural politics that sought to establish them as heirs to the tradition of Arabic and Persian scientific knowledge, literary taste and artistic sophistication, maps were transformed into narrative images sparkling like jewels. They tell of the Ottoman army's march to the east and the conquest of colourful cities containing splendid architecture and idyllic nature in eastern Anatolia and western Iran. They celebrate the Ottoman navy's exploits in the Mediterranean Sea even if the one or the other ended with defeat. They commemorate the bloody realities of besieging highly fortified towns on the Balkans and in Hungary by a splendid display of Ottoman might and regularly positioned forces and cannons. Courtly historians, painters and calligraphers cooperated in transforming the death and suffering of Ottoman soldiers, civilians and 'the enemy' into the most beautiful picture maps produced in an Islamic society. *Beyan-i Menazil-i Sefer-i 'Irakeyn-i Sultan Süleyman Han* (1537-1538) (Description of the Resting Places on Sultan Süleyman Han's Journey to the Two Iraqs) by Matrakî Nasuh (d. 1564) is one such lavishly illuminated war report.³¹ Matrakî was an officer in the Janissary corps. It is assumed that he drew maps or at least sketched the regions he passed through during a campaign. Rogers believes that sketching in the field 'may have been Matrakî Nasuh's own' innovation.³² Other art historians have shown that several painters contributed to illustrating his report, that Matrakî did not actually write the extant copy himself and that he probably did not draw or better, paint, any of the maps and city views which adorn this book.³³ They see him rather as the supervisor of the scribes and painters involved in the project. His role in the production of later illustrated books on Süleyman's campaigns seems to be even less clear.³⁴ Nonetheless, he is accepted as an artist who contributed to a style in Ottoman

painting during the sixteenth century that is dubbed ‘realistic’. Rogers even sees him as the inventor of this style.³⁵ It is this artistic orientation and the integration of maps into painting that contributed equally, if not more, to the striking difference between the much earlier Arabic and Persian road maps and those in the books of Matrakî Nasuh and other Ottoman histories of the sixteenth century. Ottoman mapmaking was as much a task being executed by painters in the court workshop as it was a domain of artisans working in the markets of the capital, in the Janissary corps and in the Ottoman navy.³⁶

When appropriating earlier—mostly Arabic and Persian but occasionally also Greek—maps and geographies, the Ottoman court sponsored a variety of styles. Beautifully coloured maps adorn major textual representatives of earlier Islamic cartographic, geographical and cosmographic traditions. The texts were often translated into Ottoman Turkish and illustrated either in accordance with their ancestral patterns or in agreement with contemporary style and taste. One example is the maps attached to the Turkish rendition of Ibn Hawqal’s work. These maps reflect Ottoman Turkish preferences for artfully designed and executed pictorial maps that could come close to genre paintings. The inclination to treat maps like miniatures is also visible in the illustrations of non-mathematical cosmographies. The use of colours, of gentle, soft flowing forms and the integration with the text indicate that the producers of the specimens meant their work to be perceived by the customer as splendidly executed objects of the art of the book.



Image 6: Pseudo-Ibn Hawqal, Surat al-ard, Arabian Peninsula (University Library, Bologna, 3611, f 367a; Ottoman Turkish translation). Courtesy Biblioteca Universitaria, Bologna.

This approach to maps as artful images also characterizes maps of the Mediterranean and Black Seas, islands and coastal strips of the Mediterranean Sea, world maps and maps appropriated from translations of Latin atlases of the seventeenth century that had been brought to the Ottoman court as diplomatic gifts or acquired by Ottoman office-holders from a foreign visitor to the capital. Piri Re'is' (ca. 1465-executed in 1554/1555) *Kitab-i Bahriyye* (Maritime Handbook) was purposefully designed to appeal to two Ottoman sultans in the first half of the sixteenth century, Selim I (r. 1512-1520) and Süleyman (r. 1520-1566), in order to gain their patronage. Unsuccessful in the first round, Piri Re'is' was advised to improve the appearance and readability of his work. This second edition of the *Kitab-i Bahriyye* was highly successful among the educated elite of the Ottoman Empire. Numerous copies with wonderful paintings of towns, fortresses, islands and coastal lines such as Venice, Ferrara, Rhodes or Tunisia were created in art workshops of Istanbul and probably other towns and can be found today in many libraries across the globe. While mostly unsigned, the artistic quality of a good number of these copies is impressive. The styles are diverse and cannot always be localized. In some cases it is obvious that Italian landscape and fortress painting had inspired the artist. Other images take up styles of the Italian *isolarii* or Island books.

Two major cartographic projects undertaken by Ottoman scholars during the seventeenth century centred on the translation of two Latin atlases, Gerard Mercator's (1512-1594) *Atlas Minor* in Henricus Hondius' (1587-1638) 1622 edition and Willem J. Blaeu's (1567-1638) *Atlas Maior* published by his son Joan (1596-1673) in 1662. The first was translated by the well-known Ottoman author Hajji Khalifa, also called Katib Çelebi

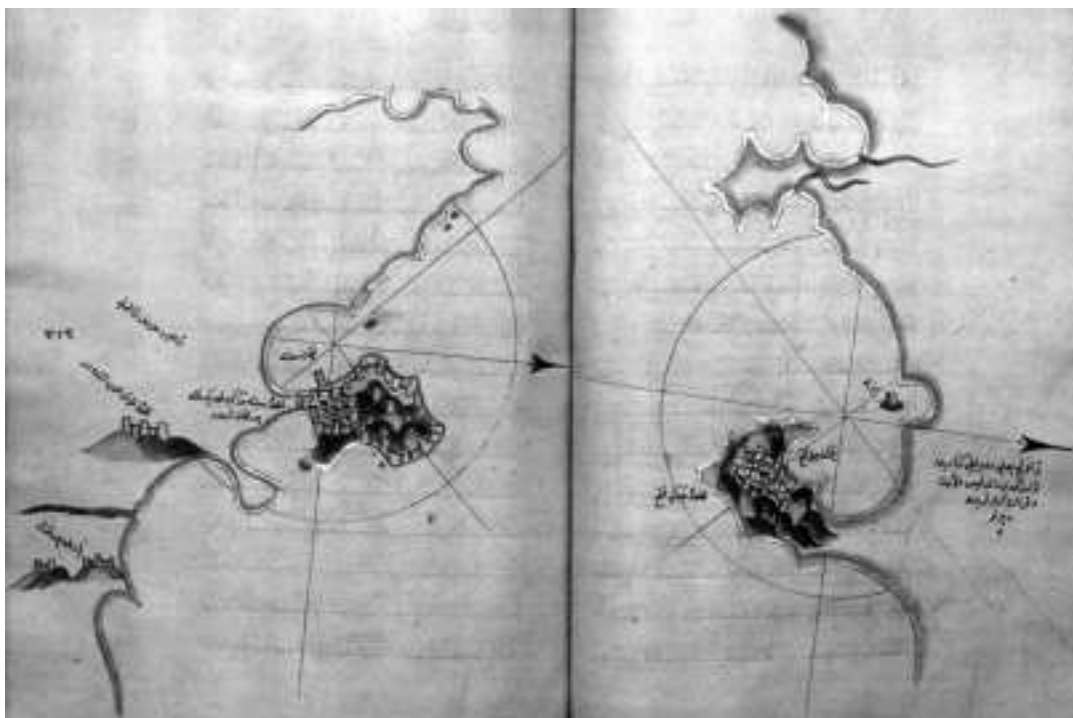


Image 7: Piri Re'is, *Kitab-i bahriyye*, Iberian Peninsula and the Maghrib (Istanbul, Süleymaniye, Köprülü 173). Courtesy Süleymaniye Library, Istanbul.

(d. 1658), in cooperation with Mehmet Ikhlasî, a convert of probably French origin. The second was undertaken by the astronomer cum *madrassa* teacher Abu Bakr al-Dimashqî (d. 1692) who is said to have worked together with the Greek physician and diplomat of the Ottoman court, Alessandro Maurocordato (1641-1709), and afterwards with Jesuits working in the mission of Chios. While the maps of the *Atlas Minor* were uncoloured and mostly unadorned, the maps of the *Atlas Maior* were often very colourful and richly decorated with figures representing major political powers, such as the Habsburg kings or the Ottoman sultans, along with couples from different nations and peoples and plans of important cities. Except for the colours, none of these artistic elements of Blaeu's maps were preserved in the Ottoman maps accompanying the translation.

The autographs of Hajji Khalifa's and Mehmet Ikhlasî's translation as well as Hajji Khalifa's own geographical work, the so-called *Cihannüma*, version II, lack any allusion to art. They are sketches in black and red ink, often incomplete. The connection to art arose only in the process of copying. Some of the early eighteenth-century copies of Hajji Khalifa's *Cihannüma*, version II, contain beautiful maps painted in pastel colours and integrated into the geographical text like a miniature integrated into a Persian or Ottoman Turkish history or literary collection.



Image 8: Hajji Khalifa, *Cihannüma*, Ptolemaic Universe (Istanbul, Süleymaniye, Hamidiyye 988). Courtesy Süleymaniye Library, Istanbul.



Image 9: Hajji Khalifa, *Cihannüma*, Kabul (Paris, BnF, Supplément Turc 215, f137).
 Courtesy Bibliothèque nationale de France, Paris.

The painters of these maps were not mere copyists. They also completed the unfinished images of the autographs, corrected them occasionally according to more recent cartographic models and added new maps based on eighteenth-century products from Germany or France that had arrived in Istanbul. In contrast to this approach to foreign cartographic specimens, the maps accompanying Abu Bakr al-Dimashqi's rendition of the *Atlas Maior* preserved visibly their foreign origin in the fine copy made for Sultan Mehmet IV (r. 1648-1687) as well as in many later copies. They were visually and materially independent of the text. In some manuscripts the maps were attached to the wrong chapters and clearly stitched in long after the text had been written.

A similarly ambiguous relationship characterizes the way in which the maps illustrating the manuscripts of Hajji Khalifa and Abu Bakr al-Dimashqi deal with the political composition of the world. In the autograph of the translation, Hajji Khalifa and his French partner Mehmet Ikhlasî followed closely the views about the political division of Europe and Asia as propagated by the Dutch cartographers. They merely transliterated

the names of the towns, rivers, oceans, mountains, deserts, lakes and states or political units, tried to find culturally feasible interpretations and copied the boundaries or frames separating such units from their neighbours. In the *Atlas Minor*, the Ottoman Empire is limited to Anatolia, Syria and some parts of Arabia. Egypt, Cyprus, and the Ottoman territories in Greece, on the Balkans and in Hungary are at best symbolically marked as ruled by the sultan. The Safavid Empire is portrayed in one single map with boundaries that are imprecise in the Caucasus region and do not reflect the latest situation in regard to Iraq. In the autograph of Hajji Khalifa's *Cihannüma*, version II, the Ottoman Empire is not mapped at all and the Safavid Empire has disintegrated into a series of maps showing Iranian provinces as in pre-Safavid geographical writing. Abu Bakr al-Dimashqi's fine copy of the translation of the *Atlas Maior* does not contain any map of the Ottoman or of the Safavid Empires. Later paraphrases of the work map the two Muslim neighbouring states as found in European atlases — in other words, with the Ottoman Empire clipped to Anatolia and the Safavid Empire with borders that fit more the situation of the early nineteenth than that of the late seventeenth or early eighteenth centuries, when these maps were painted in Istanbul. The first Ottoman map known to me that names Anatolia and even parts of Iran *Memleket-e devlet-e aliye* (Kingdom of the Supreme Dynasty), but continues to disregard the matter of precise boundaries of the empire in contrast to other states in Europe, is a silk map painted in Istanbul in 1768. This map too follows without further reflection the structuring of the political space as seen in Catholic and Protestant Europe. A rupture with this disrespect for the political status and extension of the Ottoman state in Ottoman mapmaking occurred only in the nineteenth century, when the modernized Ottoman army and its Western advisors took a fresh interest in mapping the Ottoman territories because of military and economic reasons.

5. SCIENCES IN THE *ZABAN-I HAL* POETRY AND PROSE

Poems and prose when talking of God, nature, power and man utilized a variety of artistic means to render the author's ideas in ways attractive to his clients. One such device was to let inanimate things speak as if they had a human voice (*zaban-i hal*). Pen and Sword, Rose and Nightingale, Spring and Autumn, Summer and Winter, Sun and Moon, Night and Day, Load Stone and Iron, Mercury and Love, Reason and Love, Reason and Knowledge, and Nard and Shatranj were among the most often engaged protagonists in such settings. In the Ilkhanid period, poems appeared that went beyond the artistic play with such opposites discussing their intellectual backgrounds. Riza al-Din Imami Haravi (d. 1287/88) composed for instance a philosophical *qasida* of twenty-one verses in which he described his travel from the world of the senses into the higher worlds according to the teachings of the Ikhwan al-Safa'. Passing through the three kingdoms of nature (minerals, plants, animals), the traveller ascends to the spheres of planets and fixed stars. His journeys continue further up into the spheres of Neoplatonic philosophy of the Universal Soul and Universal Reason to the Supreme Beginning and the First Cause.³⁷



Image 10: Map of Europe and Asia (Istanbul, Archaeological Museum, Silk, Two Extracts). Courtesy Archaeological Museum, Istanbul.

While many of these presentations were made in the form of poems, a special prose form called *munazara*, that is, debate, was also used for discussing the relative merits of two opponents. In the *munazara*, in addition to the inanimate things of nature, human beings—among them representatives of professions such as physicians and astrologers—entered the fray. In such cases, the opponents belong to different ethnic groups, religions or regions—a physician from Kirman debates with a Greek astrologer, an Arab discusses with an Ajami, that is, a non-Arab, and mostly someone from western Iran, or a Muslim encounters a Zoroastrian.³⁸

Two of the earliest writers of *munazaras* in Persian were Abu Nasr Ahmad b. Mansur Asadi and his son Abu Mansur Ali b. Ahmad Asadi (eleventh century). In *Shab o Ruz*, Abu Nasr compares the Evening with the Lunar Year of the Arabs and the Day with the Solar Year of the Iranians.³⁹ His son Abu Mansur presents in *Asman o Zamin* the two protagonists Heaven and Earth with their religious features such as God's Throne, Pen and Tablet. But he also draws on scientific ideas when he describes Heaven as eternally revolving due to the power of the Creator and as the place of nature, that is, the four elements Earth, Water, Fire, and Air, whose natures are cold, hot, dry and wet, combined in pairs.⁴⁰

Two centuries later, Ala' al-Dawla Simnani (1261-1335/36), one of the Sufi masters of the thirteenth century, demonstrated his familiarity with the basic theories of natural philosophy when he composed short verses in which the Heart asks the Earth why it can see the Water above it, but not in it and the Earth answers that this is so because both are at their natural place, that is, the element Earth rests in the centre of the Universe and the element Water rests in a sphere above the Earth and below the Moon.⁴¹

Debates between a physician and an astrologer were cast in the literary form by Hamid al-Din 'Umar Balkhi (d. 1163/64) and Sayyid Muhammad Mu'min b. Muhammad Qasim Jaza'iri (1663/4-1718).⁴² Hamid was a judge, possibly in Balkh. He wrote a book called *Maqamat-i Hamidi* (Hamid's Séances), a collection of stories in which a master teaches his students the fine art of literature. Not all the students are human beings of flesh and blood. Some of them represent imaginary figures such as Reason and Revelation or *zaban-i hal*.⁴³

In his *munazara* about 'aql and naql (Reason and Revelation), Hamid al-Din gives a *Pir* (an old, wise man) from the Volga Bulgars the duty to represent and defend Reason and appoints an old, wise man from the mountains to represent and defend Revelation. The Bulgarian *Pir* is a scholar clad in a *taylasan*. The *Pir* from the mountains wears a uniform and is also called a soldier. The latter opens the debate enquiring how his opponent knows God and how he names the Creator. The scholar tells him off by reminding him that this is the question of the angels *Munkar* and *Nakir*, and then tells him that in order to acquire knowledge one needs a subject and tools. The prime instrument in respect to the subject is sound reasoning, which delivers argument or proof even for revealed knowledge. He believes that reason is superior to revealed knowledge and that it is true that there are many lies and false claims side by side with truthful statements to be found among the latter, while reason is the torch for the way towards, and the guide to, success.⁴⁴

The soldier rebuffs the scholar by declaring his confidence in reason, his assumptions about reason's capabilities as non-Islamic and not unequivocally accepted, and by ridiculing his specific beliefs of the prime mover, that is, God. Then he turns to the major points of the much older debate about *taklif*, the covenant of God, between the Mu'tazilites (the first major proponents of *kalam* and the prominent role of reason) and the *ahl al-sunna* (the adherents of tradition who argued for predestination and God's anthropomorphic characteristics as stated in the *Qur'an*). He indirectly accuses the scholar of disregarding within his own theoretical framework the conceptual differences between the notion of *'illa* (cause) and *shart* (condition). *'Illa*, says the soldier, brings

about a change in the essence, for instance of a disease, while *shart* is an aspect of the attributes. Hence, reason can only be a condition of *taklif*, not its cause.⁴⁵

The scholar, undaunted, ventures into a long discourse about the necessity of instruments in order to hear, see and at the end, to know this world. And since the act of knowing and finding out the essence of the Divine never ends, compound tools are needed for it. But these tools cannot be composed of the elements and substances of this world, that is, the senses. Hence, reason is needed as a guide to instruct how the planetary orbs come into being and kingdoms emerge. It was decreed that reason is the measure of verity, the balance of justice, the astrolabe of certainty and the wisdom of knowledge. It is this enlightening reason alone that can lead man to the knowledge of Divine essence and attributes.⁴⁶

In the debate between the physician and the astrologer, Hamid al-Din advertises the strengths and weaknesses of each discipline. The debate is set in a teaching circle at the Great Mosque of Sarakhs. The physician has a number of drugs and a book with him, while the astrologer brought an almanac and an astrolabe. The physician comes from Kirman and the astrologer is a Greek. This configuration reflects an older tradition since a Greek astrologer is not very likely in thirteenth-century Sarakhs unless he was a convert, and perhaps a former slave like the twelfth-century astronomer and physician Abu l-Fath 'Abd al-Rahman Khazini (d. 1121) who worked in Merv and was the author of a *Zij* (astronomical handbook), a book on astronomical instruments and a book on the hydrostatic balance. The astrologer begins the debate by denigrating medicine and physicians. He accuses the latter, among other things, of usurping the name of Aristotle as a *laqab* (name of honour), of depending on the books of Ibn Sina (d. 1037) and of imitating the work of Muhammad b. Zakariya' Razi (864-930). He goes on to claim that his sparring partner does not understand the regularities and structures of the world of attributes and the particular role of the sublunar sphere in it, and assures him that nobody who lacks the knowledge of the universals will ever grasp the essence and truth of the branches and particularities.

The astrologer then turns to praising his own discipline, which of course is the foundation of all sciences including medicine. Prescribed remedies will simply not work to the fullest if the auspicious hour for taking them is not determined first. Time cannot be understood if its philosophical and physical basis remains unknown. Time is the expression of the revolution of planetary orbs around the sphere of the earth, but these follow different periods, sometimes producing humidity, sometimes cold; sometimes they bring forth fortune, sometimes misfortune. And all bodies made of flesh are intimately linked to the zodiacal signs that are in the ecliptic. He then continues to expound ancient medical and philosophical theories. At the end he confirms with a *Qur'anic* verse that all things he had talked about were of Divine making.⁴⁷

The physician, in his turn, takes up the relationship between the macro cosmos (the universe) and the micro cosmos (the human body) and says that knowing the human soul and the miracles of the path is more important than knowing the planets and their revolutions, since it leads to knowing the Creator. True philosophy is the knowledge of the soul, the physician emphasises.⁴⁸ The astrologer agrees with the physician's views, praises him for his words, embraces him and reconciles with him.⁴⁹

The device of *zaban-i hal* was even used in texts that dealt with more specific scientific subjects or compared more than two disciplines. The physician Abu Bakr Qunyawi (d. 1391/92), for instance, composed a *Munazara* between the Heart and the Brain in which the Brain declares that it is the seat of the noble faculty and the mine of emotions, the treasury of wisdom and the source of the five senses, while the Heart emphasizes that it reigns over the members, sends life to the body and is located in the middle of the chest, which is the noblest and most beautiful location of all.⁵⁰

Such poems and debates illustrate how deeply ancient philosophical ideas and concepts permeated the educated milieus of the *madrasas*, the Sufi convents and the courts over time. This confirms the impressions gained from other kinds of literature such as letters and metaphysical treatises. Philosophical and scientific concepts from antiquity were adopted and adapted to religious ideas derived from the *Qur'an* and developed in *hadith* and *kalam*, in ways that they either permeated and mutually sustained each other or were able to coexist side by side.

6. DIDACTIC POETRY FOR THE SCIENCES

Poetry was of extraordinary importance in several Islamic societies despite the problems that surrounded it due to its contested status in the *Qur'an* and the closeness seen between it and sorcery in pre-Islamic and early Islamic Arab societies. The revival of certain aspects of Arab tribal culture under the Umayyad dynasty in Damascus gave poetry a stable courtly home. Following the Umayyad dynasty, many ruling families in Islamic societies patronized court poets. Examples are the immediate successors of the Umayyads, that is, the Abbasid dynasty which ruled in Baghdad from 750 to 1258, the Samanid court in Bukhara in the tenth century, the Ghaznavids in Ghazna in the eleventh century, the Sultans of Delhi in the thirteenth century, the Timurids in Herat, Samarkand, Shiraz or Isfahan in the fifteenth century, the Ottomans in Bursa, Edirne and Istanbul from the fourteenth to the twentieth century and the Mughals in Delhi, Agra and Lahore from the sixteenth to the nineteenth century. The court poets created a rich poetry in Arabic, Persian, Ottoman Turkish and Urdu, which embraced the *qasida* and the *mathnavi* for panegyrics, epic, lyrics or elegies and the *ghazal* for lyrics. A specific kind of *qasida* was the *qit'a* or fragment that lacked the introductory parts. Other poetic forms were the *urjuza* and the *nazm* or *manzum* with a similarly broad range of themes as the *qasida* and the *mathnavi* and the *ruba'iyat*. *Qasida*, *urjuza*, *mathnavi* and *nazm* were longer poems, many of which could include several hundred verses (*qasida*, *nazm*) or even thousands of couplets (*mathnavi*). *Ghazal* and *ruba'iyat*, in contrast, were short poems of seven to twelve (*ghazal*) or four (*ruba'iyat*) lines.

Scientific subjects were handled in *qasidas*, *urjuzas*, *nazms* and *mathnavis*. The earliest and one of the most famous poems on scientific subjects is Ibn Sina's *Urjuza fi l'tibb*, a poem of 1326 verses on medical theory and diseases, starting from the head and going down the body to the feet. It consists of two parts, the first on general medical principles and the second on regimen and therapeutics. The poem reflects the basics of Ibn Sina's views on medicine: principles, observations, prognosis and therapeutics by means of diet, drugs and surgical techniques. Through the various Latin translations of

Ibn Sina's poem made in the thirteenth and fourteenth centuries, it became part of the medical training at mediaeval and early modern universities in Paris, Oxford, Cambridge, Padua, Prague or Leipzig. The term *urjuza* comes from the metre it uses, the *rajaz*. *Rajaz* is said to derive from shouting matches between the champions of two armies before a battle. It is considered to be the easiest metre open to the beginner. Its verses are quickly learned, because the stanzas are short and the rhythm is light.

While there are a number of other medical poems, very few scholars of Ibn Sina's rank wrote poetry in other scientific disciplines. Research writing was mostly done in prose. One of the few leading scholars of the mathematical sciences — which then included number theory, theoretical geometry, astronomy and theoretical music or theory of proportions as main disciplines, and as branches had fields like optics, surveying, business calculations, Indian arithmetic, mental calculations or algebra — who may have written poems on some of his mathematical interests was Ibn al-Haytham (d. ca. 1042). We know of two poems – one on the determination of the *qibla* or prayer direction, that is, the direction towards Mecca, the prayer times and the ascensions, the other on the entry of the Sun into the Lunar Mansions – only through commentaries by a scholar from Ceuta who was interested in grammar, geometry and astronomy, named Muhammad al-Sabti al-Lakhmi (d. 1174). One copy of each commentary is extant and preserved today in Fes and Cairo. However, since neither of the poems is included in the list of Ibn al-Haytham's works as transmitted by eminent medieval biographers and scholars like the Damascene physician Ibn abi Usaybi'a (1203/4-1270), and since neither of the two commentaries has so far been analysed thoroughly, the question of their authorship by Ibn al-Haytham is still open.

Important religious scholars too composed scientific poetry – Fakhr al-Din Razi (1149-1209), for instance. Strongly interested in astrology, he wrote a poem on the visibility of Mercury, a copy of which is extant in Cairo. One of the most successful mathematical poems written in Arabic is Muhammad b. al-Yasamin's (assassinated in 1204 in Marrakesh) *Urjuza* or *Manzuma al-Yasamiyya fi'l-jabr wa'l-muqabala* (Al-Yasamin's Poem on Algebra). In fifty-eight verses, it explains the basic concepts, methods and rules of algebra for quadratic equations. Ibn al-Yasamin was of Berber origin and a gifted poet and musician. In this capacity, he was welcomed at the Almohad court in al-Andalus. He composed his poem on algebra around 1190 in Seville and used it in his lectures on mathematics. It had a wide distribution because of the firm and generous support of *madradas* by the Ayyubid dynasty and its successors. The poem was taught for instance by madrasa-teachers in Cairo and Jerusalem. Many copies of it can be found today in libraries in West Asia, Northern Africa, Europe and the USA. Ibn al-Yasamin wrote a second – and possibly a third – mathematical poem that does not survey an entire field, but focuses on specific themes such as roots and the regula falsi⁵¹. The growth of poetry of different formats, treating a broad range of sciences, is tied to the rapid growth of the *madrasa* in West Asia and Egypt. Ibn al-Ha'im's (1352-1412) three poems on arithmetic are a point in case. Born in Jerusalem, Ibn al-Ha'im was a highly productive teacher of the arithmetical disciplines and of *fiqh*. He wrote treatises for his students and some of his friends, mostly on algebra, arithmetic and the calculation of inheritance shares. The biographical dictionary by one of his equally famous contemporaries, the *hadith* scholar and historian Shams al-Din al-Sakhawi (1427-1497),

shows beyond doubt that many of the leading scholars of his day studied at least the basics of mathematical and other rational sciences in Cairo and other centres of the Mamluk realm, and also often summarized their learning in the form of a well-stringed poem, that is, a *Nazm*.⁵²

Poems, in particular *qasidas*, served most of the time as templates for praising rulers, princes and other wealthy patrons. The importance of courtly patronage for the sciences is reflected in the numerous dedications of scientific treatises to princes, viziers and other office holders. Poems also followed this trend, as the *Khulasat-i raz* *The Essence of the Secret* indicates. It is a Persian summary in verse form of arithmetic, algebra and surveying, dedicated to Shah Jahan (r. 1628-1658) and Dara Shikuh (1615-1659). It was written in Lahore by Ata' Allah b. Ustad Ahmad (seventeenth century), one of the sons of Ahmad, the architect of the Taj Mahal.⁵³

In addition to the fields mentioned above, scholarly poetry dealt with the astrolabe, the calendar, the impact of planets on human life, the way of the Sun through the Lunar Mansions, the calculation of inheritance shares, elements of logic, parts of the human body, remedies, navigation in the Indian Ocean, and cities and countries. Most of these scientific poems were written in Arabic, Persian and Ottoman Turkish in the territories of Islamic societies in West Asia and Northern Africa. But the form of a poem for teaching and memorizing scientific knowledge was also prevalent in regions outside the classical medieval world of Islam; for instance, on the Pacific islands and in Sub-Saharan Africa. The overwhelming part of such poems was written on paper. Occasionally, the authors strove to imitate famous literary collections. Qiwam al-Din Muhammad Hasani (fl. 1694-1719), for example, created a collection of five poems on the astrolabe, arithmetic, medicine, calligraphy and proper comportment. This choice of five poems for a collection entitled *al-Khamsa al-Qazwiniyya* (*The Five from Qazvin*) reminds us of the famous *Khamsas* by Nizami and Amir Khusrau Dihlawi (1253-1325).⁵⁴

In addition to didactic poetry written on paper, there were also cases of scientific poetry being engraved on metal wares and other objects. One of the earliest known examples stems from Ibrahim b. Hilal al-Sabi' (925-994), a famous katib (secretary), poet and scholar of the Abbasid and Buyid courts in Baghdad, with solid interests in geometry and astronomy. He served five Buyid amirs, refused to convert from his Sabeian beliefs in the Divine nature of the Sun, Moon and the five planets to Islam, and was for some time in prison due to conflicts among his Buyid patrons. He was a prolific and well-reputed poet and exchanged letters about mathematical problems with a leading mathematician and astronomer of the Buyid court, Abu Sahl Wijan b. Rustam Kuhi (d. ca. 995). He constructed astronomical instruments for two Buyid amirs, 'Adud al-Dawla and his son Samsam al-Dawla (r. 983-987 in Baghdad and 990-998 in Khuzistan and Fars) and the Ziyarid ruler of Tabaristan and Jurjan in Northern Iran, Qabus b. Wushmagir (r. 976-1012). Other gifts to the three rulers were an astronomical handbook, a treatise on geometry and a set of seven pens. In three cases, these gifts were adorned by short poems, two of which were engraved on the astrolabes for the Buyid princes. The third poem went together with the pens to the Ziyarid ruler. The astrolabe with its poem for 'Adud al-Dawla was, according to Abu Zayed, King and Schmidl who have elucidated in an as yet unpublished article the story behind the instrument and the poem, a gift meant to prompt Ibrahim b. Hilal's release from prison.⁵⁵ According to the literary

sources surveyed by them, the plot worked. ‘Adud al-Dawla was pleased by the miniature astrolabe of the size of a dirham and the poem and freed the gifted poet and instrument-maker. Since the instrument has not survived the vagaries of time, the original poem too is lost. Based on the quotations from medieval collections of poetry and literature as well as on their modern editions, Abu Zayed, King and Schmidl have undertaken a reconstruction of its possible form and translated it as follows:

The petitioners [or: those hoping (for your intercession) gave you presents whilst they]
 celebrated [or: *gathered together*] on the day of the great [or: *new*] autumnal festival
 [or: *birthday*], over which you presided (with your greatness).
 But your servant Ibrāhīm, when he saw the grandeur of your status over all that might
 compete with it, [or: *when he saw that there was nothing that could compete with the grandeur of your status*],
 was not satisfied with giving you the Earth, and so he presented you with (a model of)
 the highest sphere together with all that is within it.

Variations on this poem can be found in poetical and literary collections from Iran, Syria, Egypt, the Maghrib and al-Andalus. But it did not travel on paper alone. As Abu Zayed, King and Schmidl argue in their paper, a well-known Judaeo-Arab astrolabe made in al-Andalus perhaps around 1300, presents on its rim a modified and as yet not fully understood, Hebrew version of Ibrahim b. Hilal’s poem to ‘Adud al-Dawla in Arabic letters.

The earliest extant astrolabe made in an Islamic society and engraved with a poem was created in the early thirteenth century in Isfahan. Since 1500, Persian astrolabes made in Iran, India and other regions were often adorned with poetry.⁵⁶ An example is the one by the Safavid astrolabe-maker Husayn (seventeenth century) from Isfahan, which is preserved in the National Maritime Museum at Greenwich in London. The poem runs along the rim of the instrument and informs the reader of its parts and their functions.⁵⁷ From the early seventeenth century two Indian astrolabes with poems engraved on the Mater are preserved. They were made by the astrolabe-maker ‘Abd al-Qadir Muhibb (first half of the seventeenth century), and are found today in London (Private Collection) and Frankfurt am Main (Institute for the History of Science, Johann Wolfgang Goethe University). The poem on the instrument in London praises the skills of the instrument-maker and alludes briefly to how time is determined at night. The poem on the instrument in Frankfurt repeats two verses praising the instrument-maker, continues with two verses of uncertain origin and adds two verses from Hafiz (ca. 1320-ca. 1380).⁵⁸

*I solved each difficulty of the heaven—one table after another—
 With the astrolabe of wisdom.
 Without ten and two one cannot find the secrets of heaven.*

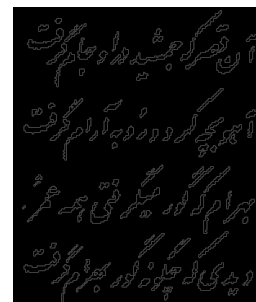
*The signs of belief can be seen from eight and four.
It takes the veil away from this world to His World
The moment it serves as the mirror of the universe.⁵⁹*

Poetry was related to the sciences in other ways too. When it had become a cultural status symbol, many scholars, independent of their disciplines, dabbled in it, even if they were not always gifted. Ibn Sina, a prolific writer of prose and of some poems on medicine and philosophy, was once attacked for an alleged lack of skill in the *belles-lettres*, in particular poetry. He scoffed and wrote a series of poems of different metres, styles and themes. Umar b. Khayyam is better known today for his quatrains than for his excellent work in mathematics, astronomy and philosophy. Ibn al-Yasamin was a gifted poet who contributed to courtly entertainment by his poems in the Andalusian *Muwashshahat* style. Some of them were also performed with music.⁶⁰ Prose texts on geography, history, astronomy, astrology and medicine included an increasing number of verses as well as quotes from the *Qur'an* and *hadith*. Writing verses in praise of a deceased person and reciting them in public emerged as early as the ninth century, as a component to the burial ceremony. If the person had been famous in some capacity, whether a physician, an astronomer or a philosopher, the verses written on the occasion might survive the centuries as in the case of the Christian physician Yuhanna b. Masawayh who died in 857 in Baghdad:

*The physician, with his medical art and his drugs,
Cannot avert a summons that has come,
What ails the physician that he dies of the disease
That he would have cured in time gone by?
There died alike he who administered the drug and he who took it,
And he who imported and sold the drug, and he who bought it.⁶¹*

Scholars of the ancient sciences were mostly remembered, until the eleventh century, in bio-bibliographical works literature in addition to their scholarly work for their wise and occasionally amusing sayings in addition to their scholarly work. At latest from the twelfth century onwards, as historical chronicles and biographical dictionaries demonstrate, the taste and the expectations changed. Scholars were now expected to write poetry in Arabic, Persian, or Turkish that went beyond the scholarly subjects. Numerous physicians, as well as astrologers/astronomers and students of the philosophical disciplines, wrote poems; . Some even composing compiled a *diwan*, that is, a collection of poems. Indeed in some regions and times the poetic *oeuvre* of a scholar could even shine brighter in some regions and times than his scholarly work, as the case of 'Umar Khayyam (d. 1135) shows:

The palace where Jamshid held his cup
The doe and the fox now rest and sup
Bahram who hunted game non-stop
Was hunted by death when his time was up.⁶²



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38. *Ibid.* pp. 99, 636.
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40. *Ibid.* pp. 99-100.
41. *Ibid.* p. 344.
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