Contribution of Muslim Astronomical Scientists to the World

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Holy Qur'an is a compete code covering all aspect of life, whether spiritual, intellectual, political, social, economic or scientific. Here I intend to discuss its scientific aspect. Islamic teaching emphasize on pursuing knowledge. Muslim scholars from the past were very much aware of this instruction given by Allah (s.w.t.) and they were very captivated by it. Many religious duties of Islam emphasized Muslims to search in the field of astronomy like the determination of direction of Holy Ka'abah. So they developed many ideas and theories in the field of astronomy. Through this paper I intend focus on the contribution of Muslim scientists to the field of astronomy and also their influence. Muslim scientists introduced the astronomical instruments and astronomical observatories that were founded by Muslims in Middle Ages, these are also mentioned here.

Keywords: Qur'an, Science, Astronomy, Muslim scientists, Observatories, Instruments.

Introduction

Astronomy was one of the oldest, most developed and most esteemed exact sciences of antiquity. Many of the mathematical sciences were originally developed to facilitate astronomical research. Beginning in astronomy had its roots in astrology and the fascination with the powers and mysteries of the heavens. Practical considerations, such a finding one's direction during night travel or understanding the correlation between the season of the year and the positions of the plants, provided additional incentives for the study of astronomy. The Babylonians, Greek, and Indians had devised elaborate systems for the study of astronomy that went beyond the simple empirical observation and were characterized by various degrees of mathematical rigor and sophistication. Before Islam, however, the Arabs had no scientific astronomy. Their knowledge was empirical, and it was limited to the division of the year into precise periods on the basis of the rising and setting of certain stars. This area of astronomical knowledge was known as *anwa;* it continued to attract attention under later Arab astronomers after the rise of Islam, and its study gained much from the mathematical methods employed by astronomers[1]. From its beginnings in the ninth and through the sixteenth centuries, astronomical activity in the Muslim world was wide spread and intensive. The first astronomical texts that were translated into Arabic in the eight century were of Indian and Persian origin. However, the greatest formative influence on Arabic astronomy is undoubtedly Greek. In its earlier stages, Arabic astronomy reworked and critically examined the observations and the computational methods of Greek astronomy and in a limited way, was able to explore problems outside its set frame. Arabic astronomy witnessed further developments in the tenth and eleventh centuries as a result of systematic astronomical research as well as developments in other branches of mathematical sciences[2].

Astronomy in Islam

All these amazing manifestation in the physical world in various forms: the process of creation, the distribution of the universe into various heavens, motion of heavenly bodies and their special characteristic, are described in the Holy Qur'an not to give lesson in astronomy or astrology, but its reflection on the glory, grandeur, control and organization of the Creator. This however, led to unity of control and direction – the unity of Creator. There are several verses of the Holy Qur'an which give some idea of the multiplicity of the heavens and the earth. The Holy Qur'an invites the attention of people towards the heaven in these words:

> "Do they not look at the sky above them? – how we have made it and adorned it, and there are no flaws in it?" (The Qur'an, L:6). "It is He who created the night and the day, and the sun and the moon: all (the celestial bodies) swim along, each in its rounded course." (The Qur'an, XXI:33).

Muslim astronomers developed their sophisticated observational and theoretical methods, they became skilled in applying astronomical knowledge to meet the fundamental requirement to worship Islamic religious practice has always necessitated precise determination of time and place, Whether in connection with prayer or with determining the beginning of months and holidays in the Muslim lunar calendar. Muslim prayers must be oriented in space as well as scheduled in time. A branch of astronomy that Medieval Muslim termed the '*ilm al-miqat,* the science of time keeping, also known as the science of the fixed moments", was applied through direct and instrumental observation as well as mathematical calculation in order to fix the five times of daily prayers, sunset, late evening, down, soon after midday, and late afternoon. The Islamic day begins at sunset[3].

Secondary because the dwellers of the desert usually travelled at night in connection with trade, war the migration from one place to another, found the direction of their journey with the help of the starts. The clear sky of the desert gave them a chance of making precise observation. Thus, there was some locally acquired knowledge of the fixed stars, the movement of the planets and the changes of the weather[4].

Muslim Astronomers and their Influence on West

Thabit ibn Qurrah (ca. 836-901 A.D.). – One of the main ninth century scientist to whom are ascribed several extant astronomical manuscripts existed today. Thabit bin Qurrah was a pagan from Harran (in south east Turkey); his native language was Syriac, but he was fluent in Greek and his working language was Arabic[5]. Belonging to the pagan sect of the Sabians and at heart deeply attached to paganism, this scholar is known as one of the most eminent representations in the Middle Ages of the tradition of classical culture[6]. Thabit joined the Banu Muser circle in Baghdad and produced numerous works on several scientific disciplines of about forty treatises on astronomy. Only eight are extant[7]. Thabit ibn Qurah, also played a major role in astronomy. In one treatise, for example, Thabit analyzed the motion of a heavenly body on an eccentrics and the model. In the course of this proof, Thabit introduced the first known mathematical analysis of motion. For the first time in history, he also referred to the speed of a moving body at a particular point[8]. In another work, Thabit provided general and exhaustive proofs for problems that Ptolemy examined only for special cares or for boundary conditions. Another work is exclusively devoted to lunar visibility. He proved the general law that applies to the visibility of any heavenly body, and then he applied this law to the special case of the crescent moon. Thabit's work is significant because it illustrates the high creativity of Arabic astronomy in its earliest periods. The roots for this creativity lie in the application of diverse mathematical disciplines to each other. This application had the immediate effect of expanding frontiers of various disciplines and introducing new scientific concepts and ideas. Thabit made astronomical observations in Baghdad, notably to determine the altitude of the sun and the length of the solar year. He recorded his observation in a book[9].

Al-Battani – Abu 'Abd Allah Muhammad ibn Jabir ibn Sinan al-Raqqi al-Harrani al-Sabi' al-Battani, was an important astronomer of the ninth to tenth century. Al-Battani was from Harran (today Altinbasak in Turkey near Urfa), and belonged to the Hellenist pagan religion of the city, but became a Muslim[10]. He lived most of his life in Taqqa (Syria) where he made most of his observations, but there is also evidence that he visited Baghdad and Antioch. He died in 929 A.D.[11]. He wrote *Kitab Marifal Matali al-Bured fi ma Bayna Arba' al-Falak,* "the book of the science of the ascensions of the signs of the zodiac in the spaces between the quadrants of the celestial sphere", *Risala fi Tahkita Akdar al-Itti Salat,* "a letter on the exact determination of the quantities of the astrological applications", *Sharh al-Makakal al-Arba li Battamiyus,* "commentary on Ptolemy's *Tetrabilon*". *Al-Zids*, work on "Astronomical treatise and tables", it was his principal work that has only survived to us; it contains the results of his observations and had a considerable influence, not only on Arab astronomy but also on the development of astronomy and spherical trigonometry in Europe in the Middle Ages and beginning of the Renaissance. It was translated into Latin by Robertus Retinensis or Tetenensis (died at Ramplona in Spain after 1143 A.D.; the version is lost). Plato Tibastinus in the first half of the 12 century (an edition of the text without the mathematical tables was published at Nuremburg in 1537 and at Bologna in 1645). Alphonso X of Castile (1252-1282) had it translated directly from the Arabic into Spanish (incomplete Ms. in Paris)[12]. Apart from a few astrological tracts which have not been studied so far, he compiled (after 901 A.D.) his *al-Zij* (astronomical hand book with tables) also called *al-zij al sabi* (Sabian zij). The *Zij* was translated twice into Latin (by Robert of Ketton and Plato of Tivoli) in the twelfth century, as well as into Spanish (thirteenth century) under the patronage of Alfanso X. It influenced strongly the Latin version of the Alfon table, was known in Jewish circles through the summary made in Hebrew by Abraham bar Hiyya (d. A.D. 1136) and was quoted by European astronomers until the seventeenth century[13]. Al-Battani made some of the most accurate observations in the annals of Islamic astronomy. He discovered the increase of the sun's apogee since the time of Ptolemy, which led to the discovery of the motion of the solar asides. He also discovered a new method for determining the time of the vision of the new moon and made detailed study of solar and lunar eclipses, used as late as in the eighteenth century by Dunthorn, in his determination of the gradual change in lunar motion. Al-Battani major astronomical work, which also contains a set of tables, became known in the west *as De Scientia Stellarum* (on the science of stars); it is one of the basic works of astronomy down to the Renaissance. It is not surprising that his work, in the edition, translation and commentary of the noted Italian scholar C.A. Nallino received a more careful study than the writing of any other Muslim astronomer during modern times[14].

Al-Khwarizmi (Fl. 830 A.D.) – Khwarizmi was great mathematics and also astronomer. His name was Muhammad ibn Musa and his origin was in Khwarizm. He was attached to the storehouse of learning of al-Ma'mun[15]. He was author of several astronomical tables and work on dails, the astrolabe and chronology[16]. The first extent original work of Arabic astronomy is al-Khwarizmi's *Zij al-Sindhand* (which is unrelated to the translation of the Indian text mentioned earlier with same name). This work contains tables for the movements of the sun, the moon and five planets, with explanatory remarks on how to use these tables. He was the master of the stars. Most of the parameters used by al-Khwarizmi are of Indian origin, while some have been derived from Ptolemy's Handy Tables, but the work could not made to harmonize the two sources. It was the original work of al-Khwarizmi. This work is significant not only for its content but also because it was written simultaneously with the earliest translations of the Almagest (Al-Majusi)[17]. Al Khwarizmi calculated the new moon's time of visibility, which helped Muslims to devise a calendar based on monthly cycles[18].

Al-Biruni – Al-Biruni, Abu Rayhan (973-1048) born of Persians that is known today as Uzbekistan, al-Biruni was a universal genius and polymath who turned his attention to every available field of learning called *al-Ustad*, "the teacher", the scope of al-Biruni's enquiries was vast and preformed, and he is a great luminary in the history of word science. When attached to the court of Mahmud of Ghaznah, he traveled with the sultan to India, where he learned Sanskrit and became a bridge between the world of Hindu leaning and Arabic-speaking Islamic civilization. Al-Biruni calculated the radius and circumference of the earth. Using the height of a mountain and its angular relationship to the horizon, he arrived at a figure for the radius of the earth which has been equated to be 6,338 km, only 15 km from the estimate of today. His figures for the circumference of the earth are less than 200 km from today's calculations. One of the proofs he gave for the sphericity of the earth is its round shadow on the moon during lunar eclipses, an observation made more than once even by ancient philosophers[19].

Habash al-Hasib – (d. between 864 and 874 A.D.) seems to have been one of the greatest astronomers working for al-Ma'mun. He edited three astronomical tables, seems to have been the first to determine the time by an altitude, and introduced the notion of shadow (umbra versa) corresponding to our tangent. He was one of the learned men interested in observation. His everlasting are his works and his books on the Dimashqi astronomical table; the Mamuni astronomical table; distance and volumes;

making of the astrolabe like sundials and computing instrument; work with surfaces like flat, upright, inclined, and oblique[20].

Al-Farghani (d. ca. 850) – A significant part of the intensive ninth century astronomical research was dedicated to the dissemination of Ptolemy's astronomy not just by translating parts or all of his work into Arabic, but also by composing summaries and commentaries on it. In the first half of the ninth century, al-Farghani for example, wrote *Kitab fi Jawami Ilm al-Nujum* (A compendium of the science of the stars). This book widely provided a brief and simplified descriptive overview of Ptolemaic cosmography, without mathematical computations. Al-Farghani gave revised values for the obliquity of the ecliptic, the processional movement of the apogees of the sun and moon, and the circumference of the earth[21].

Son of Musa ibn Shakir – Muhammad, Ahmad, and al-Hasan were the sons of Musa ibn Shakir. Three brothers, known as Banu Musa, distinguished themselves in this period; they were sons of a certain Shakir who, says a biographer, had been a brigand in his youth and harassed the road of Khorasan; he became an intimate of al-Ma'mun and one of the most esteemed scholars of his time. One of works ascribed to these three brothers, is on measurement of plane and spherical surfaces, was translated into Latin by Gerard of Cremona under the title of *Liber Trium Fratrum*[22].

Al-Balkhi – Abu Mashar Balkhi of Khorasan (born 787 A.D.) who died at the age of hundred in 886 A.D., was an astronomer and astrologer of great renown. Four of his works, including the book *De conjunctionibus et annorum revolutionibus,* were translated into Latin by Johnnes Hispalensis and Adelard of Bath[23].

Al-Mahani Abu Abd Allah Muhammad ibn Isa, (c. 860 A.D.) was one of the scholars who were authorities on calculation. He was also one of the geometricians. He worked on the latitudes of the stars[24]. His epistle was about the latitude of the star. He also wrote commentaries on Books V and X of Euclid's Elements and on the work of Archimedes on the Sphere and Cylinder[25].

Sahl bin Bishr (786-845 A.D.) an astrologer, who had already gained considerable reputation in Khorasan. There is also Abul Taiyib (c. 850 A.D.) who gave up his Jewish religion and adopted the faith of Islam. He compiled a set of astronomical tables and seems to have written on trigonometry[26].

Nasir al-Din al-Tusi – In the East in the troubled period of the Mongol inversions there flourished a great scholar with a fine synthetic brain, Nasir al-Din al-Tusi (d. 1274 A.D.). He made observations on al-Maragha in Asia Minor in an observatory founded by the munificence of the Mongol Khans and drew up the astronomical tables called after the regal title of their conquerors 'The *Ilkhanian Tables*'. The instruments at Maragha were much admired. The Arab astronomers devoted great attention to the perfecting of instruments[27]. Al-Tusi invented the linear astrolabe, an improvement on an earlier instrument used by ancient Sailors. This device, sometimes the size of a pocket watch, enabled astronomers to determine the position of the sun and other stars in relation to the horizon. The other Muslim produced plane projection of spheres allowing for the creation of maps of the hemispheres[28].

Al-Fazari: Abu Ishaq Ibrahim ibn Habib al-Fazari, a descendent of Sanurah ibn Jundab, was the first person in Islam to make the astrolabe, which he made plane and planispheric. He mentioned in his book a poem about the science of the stars; a gnomon for the determination of moon; operation with the ringed astrolabe and operation with the plane astrolabe[29].

Yahya Ibn Abi Mansur (c. 820 A.D.) was one of the men who were interested in astronomical observation during the time of Ma'mun. He verified astronomical tables and a treatise about the fixing of the sixth- hour elevation for the latitude of the city of peace Baghdad[30].

Al-Bazyar – Muhammad ibn Abd Allah ibn Umar ibn al-Bazyar was a pupil of Habash ibn Abd Allah. He was a distinguished scholars and was leader in the study of the stars. His projected works are on conjunction of the plans and revolution of the years of the world[31].

Al-Marwarrudhi – Umar ibn Muhammad al-Marwarrudhi was one of the men interested in astronomical observation. He was a person of a superior scholarly repute. Among his books there were on the planetary equation and construction of the plane astrolabe[32].

Al-Nayrizi – Abu al-Abbas al-Fadl ibn Hatim al-Nayrizi, (865-922 A.D.). Son of the prominent scholar of science of stars, especially of the science of astronomy. His books include "the large book of astronomical tables; the azimuth of the *Qiblah*; a commentary on Ptolemy's and proofs and preparation of instruments for determining the distances of objects[33].

Muslim Astronomical Instruments

Refinement in determining the lengths of the seasons, increased detail of solar and planetary motion, more exact terrestrial location of the important cities and towns – all these and more were achieved through Muslim observational astronomy, thanks not only to the skill and diligence of the observers but also to the increasing quality developed at the hands of Muslims in such valuable observational instruments[34].

It was in the development and improvement of much smaller astronomical instruments that the Muslims made the most important advances. A particular case is the astrolabe: here without question, was the most important computational instrument of the Middle Ages and early Renaissance. Probably a Greek invention of about the second century BC, the astrolabe was significantly enhanced-one might say perfected by Muslims[35].

Second only to the astrolabe in importance was the astrolabe quadrant, a very simplified version of the astrolabe. Uncomplicated in construction, the quadrant, shaped like a ninety degree pie segment could be used to solve all of the standard problems of spherical astronomy (problem related to mapping feature of the celestial sphere) for a particular latitude developed by Muslims in Egypt in the event of twelfth century[36].

Another non-observational instrument the 'celestial globe' was sometimes prized for its beauty as much as for its scientific utility. Basically a teaching device, the global device was used mainly in demonstrating the apparent daily rotation of the celestial sphere (representing the universe) over a horizon, represented by a ring within which the Globe could be adjusted to reflect any terrestrial latitude[37].

Sundials-The most ancient sundial extant dates to the fifteenth century BC but the simple vertical gnomon (the style used to cast a shadow) was certainly even more ancient. The Muslims inherited the sundial from their Hellenistic predecessors – presumably they found sundials in the territories they occupied in the seventh and eighth centuries. Muslim astronomers made several notable improvements to the theory and construction of sundials[38].

Observatories

Muslims began organization and detailed observation of the skies soon after the expansion of Islam. This effort was naturally accelerated by an increasing demand for precise tables needed in preparing calendars, prayer tables, and horoscopes. A number of observatories usually founded or sponsored by caliphs and other rulers, were established at centers such as Rayy, Isfahan, and Shiraz in Persia, as well as in Egypt. Very often the establishment of the observatory was prompted first of all by royal interest in astrology[39]. In the Middle Ages, the Muslims built a great number of Observatories, such as the observatory of the *Bait al-Hikmah* ("House of Wisdom") founded by the Caliph al-Ma'mun (d. 833). The first systematic observation in Islam took place under the patronage of the caliph al-Ma'mun. One of the first undertakings that he sponsored was the careful measurement of a meridian degree in the Syrian Desert and on the Iraqi plain[40].

The observatory as an institution lasting for a considerable period seems to have been an eastern development in the late Middle Ages.

The most obvious antecedent is the observatory founded by Malik Shah (1071-1092 A.D.), probably in Isfahan. Here Umar al-Khayyam, in conjunction with collaborators, completed a *zij* and effected the reform of the Persian solar calendar. Observation was also carried out in small private observatories. Solar parameters were established and observations of the sun, moon and planets were undertaken[41]. Islamic observatories must also have influenced the work of the later European astronomers like Tycho Brahe and Keplu[42].

Conclusion

It is concluded that Islam always emphasized on acquiring the scientific knowledge. In Qur'an Allah stresses the human towards pursuing scientific knowledge. Allah calls human the *Ashraf-ul Makhluqat* because he give them mind (intellect) that to use for the search of Allah (truth).

Medieval period Muslims of the understood these Qur'anic *Ayat* and developed near about all the fields of science like medicine, mathematics, astronomy, physics, geography etc. In the field of astronomy Muslim scholar' were distinguished contributors to the famous modern age. Their works played a significant role in the European renaissance.

REFERENCES

1. Esposito, John L., (1999). *Oxford History of Islam,* New York, Oxford University Press, p. 161.
2. Esposito, John L. (Edited), (2009). *Encyclopedia of Islam and Muslim World*, Vol. 1, p. 86.
3. Turner, R. Howard, (1999). *Science in Medieval Islam – An Illustrated Introduction,* New York, Oxford University Press, p. 63.
4. Richard C. Martin (Editor in Chief), (2004). *Encyclopedia of Islam and Muslim World, op. cit.,* p. 66.
5. Esposito, John L., (1999). *Oxford History of Islam, op. cit.,* p. 168.
6. Arnold, Thomas, (1931). *Legacy of Islam,* 1st Edn., New York, Oxford University Press, p. 388.
7. *Oxford History of Islam, op. cit.,* p. 168.
8. Nasr, Seyyed Hossein, (1968). *Science and Civilization,* Harvard University Press, Cambridge, Massachusetts, p. 470.
9. *Oxford History of Islam, op. cit.,* pp. 165-166.
10. Glasse, Cyril, (1991). *The Concise Encyclopedia of Islam,* London, Stacey International, p. 66.
11. Kirmani, Zaki and Singh, N.K., (Edited), (2005). *Encyclopedia of Islamic Science and Scientist,* New Delhi, Global Vision Publishing House, p. 138.

12. E.J. Brill, (1960). *Encyclopedia of Islam,* New Edn., Vol. 1, p. 1104.
13. *Encyclopedia of Islamic Science and Scientist, op. cit.,* p. 139.
14. Nasr, Seyyed Hossein, (1968). *Science and Civilization, op. cit.,* p. 170.
15. Dodge Bayard, (Editor and Translator), (1970). *The Fihrist of al-Nadim (Fihrist Ibn Nadim),* A tenth century survey of Muslim culture, Vol. 2, New York and London, Columbia University Press, p. 652.
16. Mason, S.F., (1953). *A History of the Sciences,* London, Routledge & Kegan Paul Ltd., p. 170.
17. *Oxford History of Islam, op. cit.,* p. 163.
18. Esposito, John L., (Edited), (2004). *The Islamic World Past and Present,* Oxford University Press, p. 136.
19. Glasse, Cyril, *The Concise Encyclopedia of Islam, op. cit.,* p. 75.
20. Dodge Bayard, (Editor and Translator), (1970). *The Fihrist of al-Nadim (Fihrist Ibn Nadim),* A tenth century survey of Muslim culture, *op. cit.,* p. 635.
21. *Oxford History of Islam, op. cit.,* p. 164.
22. Arnold, *Thamous, Legacy of Islam, op. cit.,* p. 387.
23. *Ibid.*
24. *The Fihrist of al-Nadim, op. cit.,* p. 646.
25. Mason, S.F., (1953). *A History of the Sciences, op. cit.,* p. 171.
26. *Ibid.,* p. 172.
27. *Legacy of Islam, op. cit.,* p. 387.
28. *The Islamic World Past and Present,* (2009), *op. cit.,* p. 136.
29. *The Fihrist of al-Nadim, op. cit.,* p. 649.
30. *Ibid.,* p. 653.
31. *Ibid.,* p. 654.
32. *Ibid.,* p. 656.
33. *Ibid.,* p. 661.
34. Turner, R. Howard, (1997). *Science in Medieval Islam – An Illustrated Introduction, op. cit.,* p. 66.
35. *Ibid.*
36. *Ibid.,* p. 67.
37. *Ibid.*
38. Hill, Donald R., (1993). *Islamic Science and Engineering,* Edinburgh, Edinburgh University Press, p. 53.
39. Turner, R. Howard, (1997). *Science in Medieval Islam, op. cit.,* p. 65.
40. Glasse, Cyril, (1999). *The Concise Encyclopedia of Islam, op. cit.,* p. 57.
41. Hill, Donald R., (1993). *Islamic Science and Engineering, op. cit.,* p. 53.
42. *The Concise Encyclopedia of Islam,* (1999), *op. cit.,* p. 57.