

PRACTICAL ASTRONOMY IN INDO-PERSIAN SOURCES*

S.M. RAZAULLAH ANSARI**

(Received 15 March 2002; after revision 20 May, 2002)

Practical astronomy in Islamic sources is mainly concerned with the compilation of *Zijes*, astronomical-mathematical tables, used for the prediction of eclipses and calculation of planetary positions. It also covers another class of literature containing observations of comets, meteorites, and fireballs, besides the observations of lunar and solar eclipses. Here, we give an account of the Indian observations as recorded in Indo-Persian historical sources of medieval India spanning from 15th to 19th centuries. The observations recorded therein are corroborated with the records of Chinese, Arabic and European observations.

Key words : Comets, Fireballs, Indian astronomical observations, Lunar eclipses, Meteorites, Solar eclipses.

INTRODUCTION

Practical astronomy in Islamic sources is a class by itself. It is mainly concerned with compilation of *Zijes*, the astronomical-mathematical tables, the treatises on astronomical instruments, particularly on astrolabes, astronomical observations etc. From the standpoint of applied astronomy, a *Zij* consists of particularly eclipse tables, visibility tables – for lunar crescent, apparitions and disappearances of planets—geographical and star tables. There is another class of scientific literature in practical astronomy which deals with the observations of comets, fireballs and meteorites. To this class belong the treatises on atmospheric phenomena (*Athar-i 'Ullawai*), chronicles and histories in Arabic¹ and Persian.

*Paper presented at the Joint Discussion on Applied Historical Astronomy, held during the 24th General Assembly of the International Astronomical Union, and organised by the Commission 41 (History of Astronomy), in Manchester (UK), Aug. 11, 2000.

**Roshan Villa, Muzammil Manzil, Dodhpur, Aligarh, India

During Medieval India we have Indo-Persian histories by Abū al-Faḍl (commonly written as Abul Fazl), Badāyūnī, °Arif Qandahārī (16-17th c.), to name just a few, which contain some details of various celestial phenomena. On the basis of these sources, we will enumerate here the following observations: comets of 1264, 1400/01, 1433/34, 1577, 1618, 1741-42 and of 1825; solar eclipses of 31/7/1590, 14/12/1610, and of 8/4/1615, lunar eclipse of 20/1/1609—the last three were observed and described by the Mughal Emperor Jahāngīr himself; a meteorite of 19/4/1621 and a fireball of 2/3/1742.

COMETS

According to our preliminary survey the historical sources speak of seven comets. In the following we present a brief account of each of them.²

1. The comet of 662 AH/1264 AD has been mentioned by Mughal Emperor Akbar's chronicler Shaykh Abul Fazl (1551-1602 in his *History of Akbar*).³ No detailed account of this comet is given, apart from mentioning that it was visible in Central Asia and China. Actually this comet was recorded by Japanese, Korean, Chinese and Europeans during July 7-Oct. 9, 1264. There exist also the 14th and 15th centuries reports by Arab scholars.⁴

2. Abul Fazl mentions also a comet of 803 AH/1400-1 AD, as visible in Asia Minor.⁵ In a Japanese text this "guest star" was recorded as seen during Sept. 30-Oct. 28, 1399, in the southern sky. According to French sighting, "a star of extraordinary brilliance appeared with a tail pointing westward".⁶

3. The comet of 837 AH/1433-34 AD was also taken note by Abul Fazl. According to him the shape of its tail changed to a spear form later.⁷ In the literature we find Chinese, Korean and Japanese reports of its sightings during April 14-Oct. 21, 1433. Arab sources of the 15th-16th c. specifically mention its tail "as lock of hair about 9° long".⁸

4. Quite a detailed account of the comet of 1577 is given in historical sources by Abul Fazal in his *Akbarnāmah*⁹, by °Arif Qandahārī in his *History of Akbar* (written in 1759), and also by °Abdul Qādir Badāyūnī (1540-1615)

in his *History*.¹⁰ Both Abul Fazal and Qandahārī gave the exact date of the appearance of this comet as Nov. 7, 1577. The longest tail and brilliance of this comet was noticed and that "it remained visible for about four *gharies* (that is, 1 hr 36 min) every evening, and was seen in the cities of Agra, Delhi and Lahore. It disappeared on Jan. 1, 1578".¹¹ The importance of this comet in Europe can be assessed, in the first instance, by the fact that about 20 monographs were written on it; they are still extant.¹² Moreover, it earned its reputation from quite accurate observations of Tycho Brahe, whose negative result of its parallax proved that the comets are not phenomena of terrestrial atmosphere; on the contrary they belong to interplanetary space.¹³

5. The comet of 1618 was reported by the Mughal Emperor Jahāngīr (ruled 1605-1627) himself in his *Memoirs* and by Muṣṭamid Khān (d. 1639) in the second part of the Emperor's *Memoirs*. Jahāngīr gives a long description.¹⁴

According to European records, three comets appeared in 1618: (i) Aug. 25–Sept. 25 (last seen), (ii) Nov. 11–Dec. 9, and (iii) Nov. 25–Jan. 22, 1619. Jahāngīr's observation falls in the category C-1618 (ii), for which there exist Chinese, Korean and Philippine reports also.¹⁵ The European keen interest in this comet is indicated by the writing of 28 monographs, which set includes a short monograph by Kepler himself.¹⁶

6. Another comet of 1154 AH/1741–42 AD has been reported by the historian Sayyid Muhammad ʿAlī al-Husaynī. According to him, the comet appeared in the evening during Dec. 1741–Feb. 1742.¹⁷ This comet was observed in Europe. It is listed in the *Catalogue* of Crommelin, with the date of its perihelion as Feb. 7, 1742.¹⁸ J.B. Wiedeburg published a monograph in German on the same comet.¹⁹

7. Finally the comet of 1825 was observed by an Indian Astronomer-mathematician Ghulām Husain Jaunpūrī (1790-1862) in his *Encyclopaedia of Sciences*²⁰, written during 1832-1833. While discussing the comets, he mentions a comet which appeared with its tail along its motion, in the city of Benares. He informs further that the longitude of its centre on 13 Šafar 1241 AH (i.e., 26th September 1825 AD) was 1;6,20 and the latitude 20;30

south, and on 22 Safar 1241 AH (i.e., 5th October 1825 AD) was 1;4,40 and 25;55 respectively. He deduced from these observations that during the 9 days the comet moved nearly 5 degrees, and the direction of its tail was exactly towards west.²¹ Now we find in Crommelin's List, a comet which appeared in 1825 with a perihelion passage on May 30.52280 (GMT).²²

ECLIPSES

Despite the superstition attached to eclipses, particularly to the solar eclipses, very few reports on solar and lunar eclipses are available in literature to-date. We give a brief account of five solar eclipses and three lunar eclipses in the following:

Solar Eclipses

1. During the reign of emperor Akbar (1556-1605), only one solar eclipse has been reported by Abul Fazl in his *Akbarnāma*.²³ He states the occurrence of the solar eclipse on 23rd Amardād or the 35th Regnal year (Ilāhī). According to Schram's Table A (p. 125), an annular or total solar eclipse was visible in India on Tuesday July 31, 1590 AD (Gregorian), which corresponds to Ramadān 29, 998 AH. According to Moosvi,²⁴ the date 23rd Amardād of 35th Ilāhī (Akbar's) era may be considered as a scribal error and is to be corrected to 8th Amardād, which corresponds exactly to Schram's entry.

Noteworthy is the following: During Akbar's reign a total of 39 solar eclipses were visible in India.²⁵ Out of these 18 were total and 17 were annular; and therefore quite important. Moreover 14 eclipses occurred after the year 1590 AD. Strangely enough these eclipses have not been reported in the literature.

Emperor Jahāngīr son of Akbar (reign 1605-1627) was very much interested in natural history. In his *Memoirs* he gives an account of two solar eclipses:

2. "On 28th an eclipse took place."²⁶ Jahāngīr is alluding here to the month of Azar (*Ādhar*) in his fifth Regnal year (1610 AD).²⁷ But if that date is considered to be a scribal error and it is amended to 8th (of the next

month of *Dai*) then it turns out to be the 30th Ramaḍān 1019 AH corresponding to December 5, 1610 AD (Julian), precisely on which an annular solar eclipse did occur.²⁸ Our emendation is reasonable, since Jahāngīr notes earlier in another place: “On 28th corresponding to 21st Ramaḍān 44 elephants sent by Hāshim Khān [as] offering from Orissa.”²⁹

3. “On Sunday 9th there was a (solar) eclipse, when 12 *gharīs* of the day had passed. It began from the west and four-fifth of the Sun was eclipsed...” He further states that “it lasted 8 *gharīs* (3^h 12^m)”.³⁰ Here the date refers to the 9th *Farwirdīn*³¹ corresponding to 29th *Safar* 1024 AH, i.e., 19 March 1615 AD (Julian), this last date in turn coincides exactly with Schram’s entry for an annular solar eclipse.³²

In the following we enumerate further observations of solar eclipses from two Indian astronomical tables: *Zīj-i Muḥammad Shāhī* (ZMS), compiled in about 1730 and dedicated to Mughal emperor Muhammad Shāh (reign 1719–1748); and *Zīj-i Bahādurkhānī* (ZBK^h)³³ compiled by the astronomer Ghulām Hussain Jaunpūrī in 1838 and dedicated to his patron, Raja of Tikārī.

4. In ZMS (fol. 13), the theory of solar eclipse is illustrated by the following example that a solar eclipse, occurred in Jaipur on Monday, 30 *Dhīqa*^d 1146 AH corresponding to April 22, 1734 AD. This information tallies exactly with Schram’s entry of that date for a total eclipse.³⁴ In ZMS, it is also stated that the eclipse had begun 7 *gharīs*, 47 *pal* and 30 *bīpal*, i.e., 3^h 7^m past noon.³⁵

5. In ZBK^h, a partial solar eclipse is noted on Friday 30th *Jumādī* 1, 1258 AH corresponding to July 8, 1842 AD (Gregorian). It is further stated that the duration of the eclipse³⁶ was 10^h 4^m 14^s.

Lunar Eclipses

In this category we have three observations:

1. Emperor Jahāngīr in his *Memoirs*³⁷ had reported a total lunar eclipse which occurred on Saturday 13th *Shawwāl*, 1018 AH corresponding to December 29, 1609 AD (Julian) and January 8, 1610 (Gregorian).³⁸ The Emperor also recorded the beginning of the eclipse as 4 *gharīs* (1^h 36^m) after

dusk and its duration as 5 *gharīs* (2^h). This duration does not agree with another report of the same eclipse by ‘Abdul Hamīd Lāhorī, who in his *Pādshāhnāma* (History of Emperor Shāh Jahān) gives 1^h 52^m. This discrepancy has been explained by Moosavi, by assuming that the unit of nocturnal *gharī* (ngh) as used by Jahāngīr is shorter than the normal³⁹, i.e., 1 ngh = 22^m 24^s.

2. In ZMS, a lunar eclipse is mentioned, occurrence on Sunday, 15th *Dhulhijjah*, 1144 AH corresponding to May 28, 1732 (Julian). The beginning of the eclipse had been reported at 17 *gh*, 3 *pal* (6^h 5^m 52^s) at Jaipur.⁴⁰

3. In ZBK_h a lunar eclipse is reported to have occurred on 15th *Rajab*, 1254 AH corresponding to October 3, 1838 (Gregorian), in Gaya (Bihar province) at 8^h 38^m 11^s past noon.⁴¹

METEORITE AND FIREBALLS

In this class of celestial bodies we have two observations to report.

1. Again, Emperor Jahāngīr in his *Memoirs* had written an account of a meteorite fall in Jalandhar (Punjab), on Rabī^c II, 1030 AH, i.e., April 19, 1621 AD.⁴² The stone was about 2 kg. It was a stony iron or siderolite. Later a sword and a dagger was made out of that meteorite.⁴³

2. In his *History*, Sayyid Muḥammad ‘Alī reported about a “large fireball started from the east and proceeded towards the west”,⁴⁴ on Wednesday, Muharram 6, 1155 AH corresponding to March 2, 1742 (Julian). He further reported an earthquake having occurred at Burhanpur on Monday, 13th Muharram 1171 AH, i.e., September 15, 1757 (Julian), probably due to “the unusually large bolide passing and bursting in a region of the sky”.⁴⁵

CONCLUDING REMARKS

In this preliminary and brief survey of practical astronomy as practised during the medieval India, we have shown that the observations of celestial bodies and phenomena like comets and meteorites along with solar and

lunar eclipses have been reported in a number of historical sources. In this version of our paper we have not been able to include a number of *zījes* exclusively compiled in India during the 15th–19th centuries. There are 11 *zījes* known to-date.⁴⁶ We intend to publish elsewhere a comprehensive survey of Indo-Persian sources which throw light on the applied historical astronomy.

The author acknowledges gratefully here the financial support offered by the General Secretary of IAU and by Janab Abdul Moid, President of the Hamdard Foundation (New Delhi), which made it possible for him to attend the 24th IAU General Assembly. Thanks are also due to Mr. Peter D. Hingley (Librarian, Royal Astronomical Society, London) to allow the author to use the RAS Library sources.

NOTES AND REFERENCES

1. See the paper of Cook (1999), who deals only with Arabic sources (See Bibliography).
2. See the *first* research contribution on this topic by Moosvi (1997), which source we use *critically*. Moosvi's original source is *Akbarnāma*.
3. *Ibid.*, p. 114.
4. Cf. Kronk, pp. 217–222.
5. Moosvi, p. 114.
6. Kronk, p. 260.
7. Moosvi, p. 114.
8. Kronk, p. 267.
9. For a detailed account and an interesting discussion, see Moosvi, pp. 112–113.
10. Cf. Badāyūnī, p. 248, under the account of the years 1576–77. He relates also the comet's ill effects in Iran, Iraq and Turkey.
11. Qandahāri's report quoted by Moosvi, pp. 111–112.
12. Mary Smyth and Michael Smyth, p. 73.
13. For details cf. the article by R. Kippenhahn in *SuW*, esp. pp. 199–203.

14. Cf. Moosvi, pp. 114-115; Alvi and Rahman, pp. 137-138, wherein the Persian text is also cited. Mu'tamid Khān's report (p. 552, as cited by Moosvi, p. 115) almost coincides with that of Jahāngīr. However, Khān adds an account of its ill effects also.
15. Kronk, pp. 333-339, for the C-1618 (ii) see pp. 336-336.
16. The title is "*De Cometis Libelli Tres*", Smyth and Smyth p. 74.
17. Khan, M.A.R., p. 190, The original Persian source is *Tārīkh-i Rāḥat Afzā* (a history of Tīmūrīds), by S. Muhammad 'Ali Husaynī. The book was completed in 1759-60, and was printed in Hyderabad in 1947. This comet is mentioned on p. 143 of the Persian text.
18. Crommelin, p. 4, ref. No. 84, the name of its discoverer is not given. M.A.R. Khan mentions this reference also.
19. Smyth and Smyth, p. 78.
20. See Ansari and Sarma (1999/2000).
21. See his Encyclopaedia, p. 469.
22. Crommelin, p. 5.
23. See Moosvi (1997), p. 117. Her account of the eclipse is very interesting, as she compares expertly the two editions of *Akbarnāma*.
24. Moosvi (1997), p. 117.
25. Schram, Table A, p. 123.
26. Jahāngīr/Rogers' translation, Vol. I, p. 183.
27. Both Moosvi (p. 118) and Alvi & Rahman (p. 136) have wrongly identified that date as 28th respectively 23rd Ramadān 1019 AH.
28. Schram, Table A, p. 123.
29. Jahāngīr/Rogers' translation, Vol. I, p. 183 (line 2).
30. Jahāngīr/Rogers' translation, Vol. I, pp. 281-282, for Indian division of time see footnote 35 below.
31. Moosvi wrongly reads that date as 9th Rabi' I, 1024 AH which is actually a Tuesday. In fact Jahāngīr (Rogers, p. 280) mentions the beginning of his 10th Regnal year on Saturday 1st *Farwardīn*, corresponding to 8th *Safar* 1024

AH. Now Saturday March 21, 1615 (Gregorian) corresponds to 21st *Safar* 1024 AH. So 8th *Safar* is an scribal error. Evidently 9th *Farwardin* will correspond to the 29th *Safar* as mentioned above.

32. Schram, table A, p. 125.
33. For an introduction to this *Zij*, see Ansari (1995/96).
34. Schram, Table A, p. 126.
35. The units for the division of time in India are: 1 day = 60 *gharis* (*gh*) = 60 *pal*, 1 *pal* = 60 *bipal*. That is, 1 *gh* = 24 m, 1 *pal* = 24 sec, 1 *bipal* = 24 thirds.
36. ZBK_h, p. 530. It tallies exactly with the date of Schram's entry, p. 127.
37. Jahāngīr/Rogers' translation, Vol. I, p. 160.
38. Cf. Moosvi (1997), p. 119. Her Gregorian date: January 20, 1609, does not correspond to the given Hijri date. It has probably been taken from Sewell (1898). See also Alvi and Rahman (p. 136) whose Gregorian date is short by one day.
39. Moosvi, p. 119, footnote 33.
40. ZMS, fol. 146-147.
41. ZBK_h, p. 547.
42. For a translation of the Persian text, see Moosvi, pp. 114-115; Alvi and Rahman give both Persian text and its translation, pp. 139-140.
43. For the first report about this meteorite, see Khan (1935), p. 35. M.A.R. Khan of Hyderabad was an expert of meteoric astronomy; see also Khan (1946).
44. Husaynī, p. 143; Khan (1948), p. 190.
45. Khan (1948), p. 191; Husaynī, p. 143.
46. See Ansari (1995), esp. pp. 280-284.

BIBLIOGRAPHY

Abul Faḍl, Shaykh: *Akbarnāma*, Vol. III, edited by Ahmad 'Alī, Calcutta, English translation by H. Beveridge, Calcutta, 1987; Vol. III, Indian reprint, New Delhi. 1993.

- Alvi, M. A. and Rahman, A. *Jahāngīr—the Naturalist*, National Institute of Sciences of India (presently, Indian National Science Academy), New Delhi, 1968.
- Ansari, S.M.R. : 'On the Transmission of Arabic-Islamic Astronomy to Medieval India', *Archives Internationales d'Histoire des Sciences*, 45. 135 (1995) 273–297.
- Ansari, S.M.R.: 'Ghulām Hussain Jaunpūrī and his Zīj-i Bahādurkhānī', *Studies in History of Medicine & Science* (New Delhi), 16. 1-2 (1995/96) 181–188, new series.
- Ansari S.M.R. and Sarma, S.R. 'Ghulām Hussain Jaunpūrī and his Encyclopaedia of Sciences', *Studies in History of Med. and Science*, 16. 1-2 (1999/2000) 77–93, new series.
- Badāyūnī, 'Abdul Qādir, *Muntakhab al-Tawārīkh*, (Selection from History), 3 volumes, edited with English translation by W.H. Lowe, *Academica Asiatica*, Patna, 1973.
- Cook, David. 'A Survey of Muslim Material on Comets and Meteors', *Journal of History of Astronomy*, 30 (1999) 132–162.
- Crommelin, A.C.D.: *Memoirs of the British Astronomical Association*, 26.2 (1925).
- Habib, Irfan, Ed. *Akbar and His India*, Oxford University Press, New Delhi, 1997.
- Husaynī, S. Muhammad 'Alī: *Tārīkh Rāhat Afzā* (in Persian), published by S. Khurshīd 'Alī, Hyderabad (Deccan), 1947.
- Jahāngīr: *Tuzuk-i Jahāngīrī* (*Memoirs of Jahāngīr*), Persian Text edited by Syud Ahmad Khan, Ghazipur and Aligarh, English translation by A. Rogers and edited by H. Beveridge, 1863-64; Recent reprint in 2 volumes, Delhi, 1968, esp. Vol. II.
- Jaunpūrī, Ghulām Hussain: *Jāmi' Bahādurkhānī*, (in Persian), Lithograph, 1835.

- Khan, Mohammad A.R.: 'A Forgotten Indian Meteorite', *Nature*, 135. 3401 (1935), 39.
- Khan, Mohammad A.R.: 'Muslim Contribution to Meteoric Astronomy,' *Islamic Culture*, 20 (1946) 353–361.
- Khan, Mohammad A.R.: 'Further References to Cosmic Phenomena in the *Kitāb al-Muntazim* of Ibn al-Jauzī and a few in *Tārīkh-e-Rāhat Afza* (India), *Islamic Culture*, 22 (1948) 188–191.
- Khan, Mu'tamid: *Iqbāl-nāma-i Jahāngiri*, Vol. 3, Lucknow, 1870.
- Kippenhahn, Rudolf: 'Es begann mit Tycho and Halley. Die Kometen-Astronomie', in: *Sterne und Weltraum*, Special Issue on Comets, *Zeitschrift für Astronomie* (SuW), March/April, 1997, pp. 199-204.
- Kronk, Garry W., *Cometography, A Catalogue of Comets*, Vol. 1 (Ancient), Cambridge University Press, Cambridge, 1999.
- Moosvi, Shireen: 'Science and Superstition under Akbar and Jahāngir: The Observation of Astronomical Phenomena', in Irfan Habib (Ed.), *Akbar and His India*, 1997, pp. 109–120.
- Qandahārī, 'Arif: *Tārīkh-i Akbarī*, (History of Akbar), annotated English translation by Tasneem Ahmad, Pragati Prakashan, Delhi, 1993.
- Schram, Robert: 'Table of Eclipses of the Sun visible in India', in Sewell and Dikshit, *The Indian Calendar* p. 111 et seq, 1896.
- Sewell, R.: *Eclipses of the Moon in India*, London, 1898.
- Sewell, R. and Dikshit, S.B.: *The Indian Calendar*, London, 1896.
- Smyth, Marry F.I. and Smyth, Michael J.: *Supplement to the Catalogue of the Crawford Library of the Royal Observatory of Edinburgh*, Edinburgh, 1977.
- SuW, *Sterne und Weltraum*, 'Special issue on Comets', *Zeitschrift für Astronomie*, March–April, 1997.
- ZBK_h (1855), *Zīj-i Bahādurkhānāi*, by Ghulām Hussain Jaunpūrī, Calcutta, November 1855.
- ZMS (Tonk), *Zīj-i Muhammad Shāhī*, Ms 3639, Institute of Arabic and Persian Studies, Tonk.