Journal of Astronomical History and Heritage, 18(3), 249–260 (2015).

ABŪ'L FAẒL, INDEPENDENT DISCOVERER OF THE GREAT COMET OF 1577

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Abstract: Abū'l Faẓl, the celebrated Prime Minister of the Mughal Emperor Akbar, recorded in the *Akbarnāmā* (a highly-acclaimed biographical account of the Emperor) the appearance of a comet during the 22nd year of Akhar's reign, in 985 A.H. From the recorded date, it turns out that Abū'l Faẓl was an independent discoverer of one of the most famous comets in history—the Great Comet of 1577 (C/1577 V1).

Key words: Mughal chronicles, Abū'l Faẓl, *Akbarnāmā*, the Great Comet of 1577

1 INTRODUCTION

Abū'l Faẓl (1551–1602), who came to the court of the Mughal Emperor Jalāl ud-Din Muḥammad Akbar (1542–1605; ruled 1556–1605) in CE 1575, was a very knowledgeable person, having trained in the traditional as well as the rational (natural) sciences. He wrote in Persian the official biographical account of Akbar, the *Akbarnāmā*, and presented this to his Emperor (see Figure 1). This book would become one of the most important sources of Indian history. Abū'l Faẓl's work *Ā'in-i Akbari* (*Institutes of Akbar*; 1590), the third and concluding volume of the *Akbarnāmā* (which itself comprised five books, in Persian, translated into English in three volumes by The Asiatic Society of Bengal), is a great documentation of life, both material and spiritual.

Abū'l Faẓl was not an astronomer by profession, but in his works he presents a worldview that is scientific to the core. In the *Ā'in-i Akbari* (Blochmann and Jarrett, 1907) he describes cosmogony, geography, medicine and veterinary science, as well as the boundaries of Hindustan, the Hindu philosophy and way of life, its customs and beliefs and languages. In this he draws on parallels from the Greek scientific knowledge, and we can but marvel at his insight.

Referring to the *Sūrya Siddhānta*, Abū'l Faẓl introduces to us the concept of *byomni* (*ākāsha*, or ether), the heavens and the Earth, and the measurement of time, determination of the equinoxes, precession, assignment of stellar magnitudes, terrestrial latitude and longitude, and seasons, that he describes by means of movement of the Sun through the zodiac.

Notably, Abū'l Faẓl underlines the Emperor's interest in the study of astronomy, and a "... part of the Astronomical Tables of Ulugh Beg which we have noticed in Bābar's reign was translated under the supervision of Amīr Fatḥullāh Shī-rāzī …" (Law, 1916). In the *Akbarnāmā*, Abū'l Faẓl, writing in 1596, mentions that

> Maulāna Chānd, the astrologer ... was possessed of great acuteness and thorough dexterity in the science of the astrolabe, in the scrutinizing of astronomical tables, the construction of almanacs and the interpretation of the stars ... (Beveridge, 1897–1939, Volume 1: 69).

The astronomical tables *Tahsilāt-i-Akbar Shāhī* constructed by Maulāna Chānd were used later by Sawāi Jai Singh II (ibid.). There was no clear demarcation between astronomy and astrology, and in imperial life—both private and administrative—astrologers and astronomers had important roles to play. They were required to be present near birth chambers at the critical moments to determine exactly the celestial circumstances and draw up astrological prognostications about the newborn (e.g. see Figure 2). A manuscript, *Tuzuk-i Jahangīrī* (*Memoirs of Jahāngīr*) in the Museum of Fine Arts, Boston, features a miniature dating to ca. 1615–1620 attributed to the artist Bishandās, which depicts the birth of Prince Salīm (Jahāngīr 1569–1627), with some astrologers in attendance who are working on the horoscope. Astronomers or astrologers are featured in a number of Mughal miniatures working with with water or sand clocks, or holding ring dials (to take altitude) and celestial globes (e.g., see Sarma 1992). We also note how

> Emperor Akbar paid very great attention to the education of his sons and grandsons, and appointed learned men of very high reputation to superintend their studies. (Law, 1916: 160).

Mughal memoirs mention several astronomical phenomena, namely, fireballs and comets, and the occurrence of a number of solar and lunar eclipses. Abū'l Faẓl writes about comets in detail, and cites a few past occurrences recorded elsewhere. His interest in comets apparently was prompted by the appearance of a spectacular comet in the twenty-second year of Akbar's reign (which began in 963 A.H.).[1] Abū'l Faẓl records his observations of this comet in the *Akbarnāmā*, made during an expedition from Rajasthan to Punjab, and he also presents his own treatise on comets—even though technically this work is meant to be a biographical account about somebody else, his Emperor, and not autobiographical. Elliot (1873: 407) has identified the refence as being to the famous comet of CE 1577.

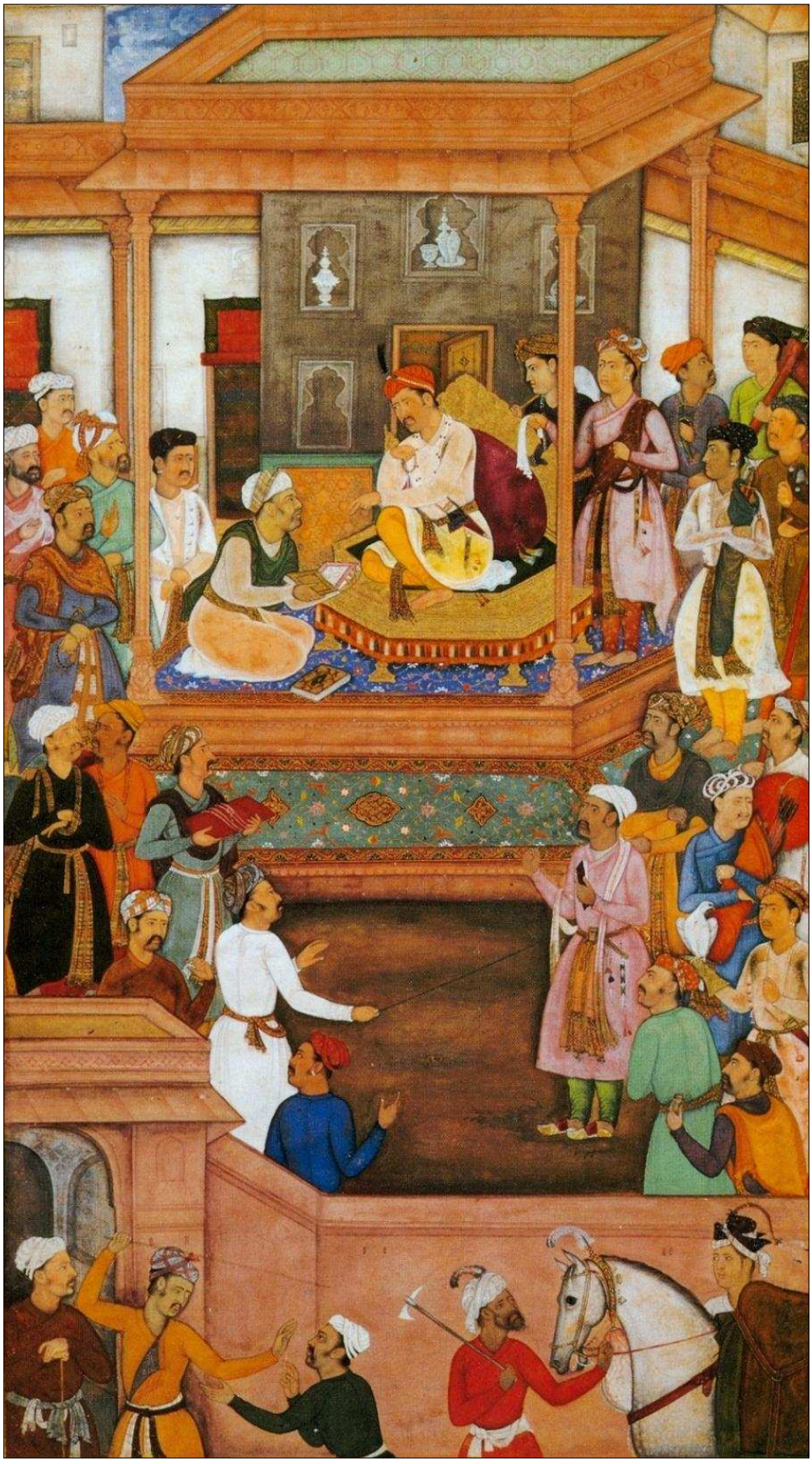

Figure 1: A miniature showing Abū'l Faẓl presenting the *Akbarnāmā* to Emperor Akbar (Wikimedia Commons).

Considering the account and the date, Abū'l Faẓl would appear to have been an independent discoverer.

2 COMET REFERENCES IN WRITINGS OF THE MUGHAL PERIOD

Unexpected phenomena like eclipses, comets, meteors, and earthquakes were regarded as ill omens by rulers and emperors, and the recording of such events in political histories was a well-established tradition in the Middle Eastern empires. Although these works are not astronomical texts, and they contain little scientific content, because they are from different cultures and ages they allow us to see how astronomical perceptions changed over time.

The most significant aspect of these writings is the dates, or sometimes the weekdays, that the scribes wrote down. While keeping in mind the text and the context in which the original references were made, these recorded dates and details can provide valuable information when they are tested against modern back-calculations. The tradition of recording 'politically-significant' cosmic events had a long uninterrupted history and, not surprisingly, even was found in India. Northern India was dominated by the Mughal Empire during the sixteenth and seventeenth centuries, and its chroniclers mentioned fireballs, comets, and a number of solar and lunar eclipses. The records reveal that these rulers were seriously concerned about the auspiciousness of such serendipitous apparitions, and that they sought counsel to tide over their possible consequences and even looked for remedial measures.

Of the numerous comet apparitions during the Mughal period, we find reference only to the Great Comets of 1577 and 1618 in the Mughal writings, namely, the *Akbarnāmā*, the *Tuzuk-i Jahāngīri* and a few chronicles (Elliot, 1873; 1875; Modi, 1917). Here, I shall focus only on the records of the Great Comet of 1577, as those relating to the Great Comets of 1618 will be discussed in a later paper (Kapoor, n.d.).

The 1577 comet is mentioned by Abū'l Faẓl's fellow chroniclers as well, namely, Mullā Abd ul-Quādir Badāūnī (d. 1615), Nizām ud-Din Ahmad Bakhshi (d. 1594) and 'Ārif Qandahārī (Hadi, 1995: 86). Badāūnī was a scholar and historian who came to the Royal Court in 1574, and his work, *Muntakhab-ut Tawārīkh*, is a general history of the Muslims in India up to the fortieth year of Akbar's reign. Nizām ud-Din, also was Akbar's courtier, and he authored *Taba-qāt-i Akbarī* (*Generations of Akbar*), which covers the general history of the Muslim rule, beginning with the coming of Islam to India and through to the thirty-ninth year of Akbar's reign. Qandahārī, who in 1580 completed his historical account, *Tārikh-i Akbar Shāhī*, was a revenue officer during Akbar's reign and is appreciated for the chronological details that he provides (Hadi, 1995; Majumdar et al., 2007).

These references assume significance in view of the fact that observations from Europe of the very same comets made a decisive impact on the course of astronomy. To glean some of this one should read the books by Hellman (1944) and Drake and O'Malley (1960). However, among the comets that shaped our worldview, the Great Comet of 1577 stands ahead of all others. When hardly any theory of comets existed, Tycho Brahe's observations of the comet were a milestone in the history of astronomy when he placed it in a supra-lunar position. This challenged the Aristotelian perception that comets were atmospheric phenomena.

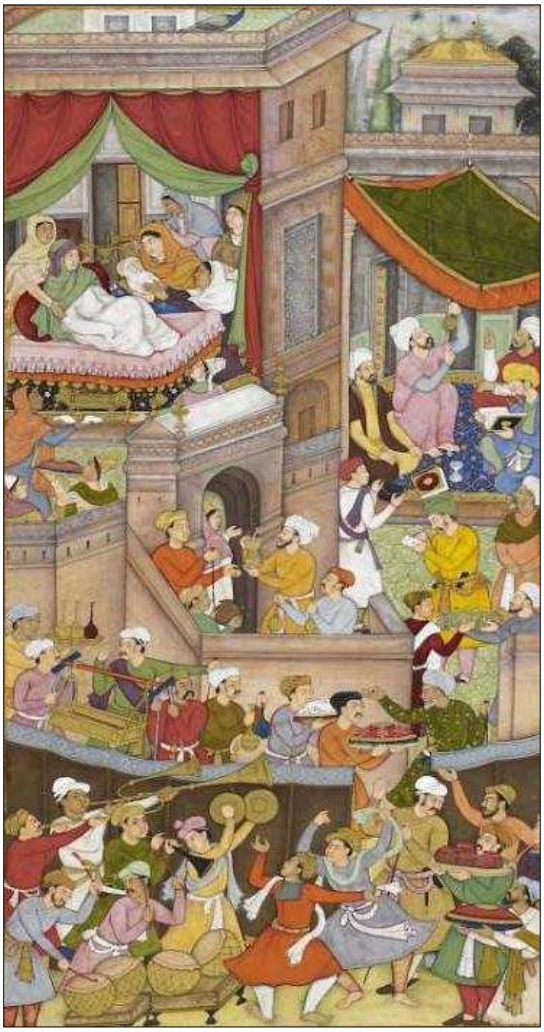

Figure 2: A painting attributed to Sūrdās Gujarātī showing the birth of Timur, with astrologers on the right drawing up the prince's horoscope. This painting is in the British Library and is thought to date to ca. 1602–1603 (after Abu l-Fażl's *Akbarnāmā, Or.12988, f. 34v*. http://www.bl.uk/manuscripts/Viewer.aspx?ref=or_12988_f034v).

Brahe's work was preceded only by the important observations made by the German geographer and astronomer Petrus Apianus (1495–1552), who viewed the Great Comet of 1531, 1P/Halley, and showed from five consecutive observations made between 13 and 17 August that its tail was always directed away from the Sun, as documented in his famous work *Cosmographia* (Kronk, 1999).

Meanwhile, the comets of 1618 belong to that era when Galileo's telescopic observations had created a paradigm shift in our perception of the heavens, and Johannes Kepler introduced a fundamental change in mathematical astronomy by redefining the planetary motion around the Sun.

3 COMETS IN THE ISLAMIC WORLD

According to Aristotle (384–322 BCE), comets were dry and warm exhalations in the upper atmosphere that belonged to the sub-lunary sphere (see his book *Meteorologica*, which dates to about 330 BCE). Islamic astronomers also regarded comets and meteors as atmospheric rather than heavenly phenomena, and so they were largely ignored. However, Ja'far ibn Muḥammad Abū Ma`shar (CE 787–886), the famous Persian astronomer, astrologer and philosopher, considered comets celestial. In *Albumasar in Sadan*, the noteworthy information recorded by his student Abu Sa'id Schadsan in CE 829, he observes that

> The philosophers say, and Aristotle himself, that comets are in the sky in the sphere of fire, and that nothing of them is formed in the heavens, and that heavens undergo no alteration. But they all have erred in this opinion. For I have seen with my own eyes a comet beyond Venus. And I know that the comet was above Venus because its colour was not affected. And many have told me that they have seen a comet beyond Jupiter and sometimes beyond Saturn. (Heiderzadeh, 2008: 29).

Upon checking modern cometographies, we find that the comet seen in CE July 821 or that in CE September 828 could be Abū Ma`shar's candidate, as Venus, too, was nearby.

Ibn Rushd (CE 1126–1198), the great philosopher and astronomer, cited Hippocrates as saying that the tail was vapour pulled by the Sun as the comet passed by it (Cook, 2008), but he also observed that in such a case a comet should sometimes be seen with a tail and at other times without one.

4 ABŪ'L FAẒL'S TREATISE ON COMETS

Abū'l Faẓl begins by introducing the subject of 'tailed stars', observing that comets belong to the realm of the physical sciences. The commentary is prefaced by a description of the formation of vapour versus steam rising from the Earth by the heat caused by the rays of the Sun. As a formation from vapour rising from the Earth, a comet is thus a terrestrial meteorological phenomenon. Abū'l Faẓl also discusses meteors, but separately from comets. In light of his gathered information, Abū'l Faẓl classifies comets into four categories:

- those possessing locks of hair (*zawat'ul zawab*)
- those with tails (*zuzanab*)
- those resembling a lance in the hands of a person
- those resembling an animal.

In the *Akbarnāmā*, Abū'l Faẓl quotes the views on comets expressed by Greek, Roman, Egyptian and Hindu scholars, and the calamities associated with them:

> The wise men of India divide them into two kinds and take them to be auspicious and inauspicious (respectively). All are unanimous in saying this, that its (i.e., the comet's) influence is reflected upon the country over whose zenith it passes or whose best inhabitants see it. It moves according to the position of the constellation in which it appears, and in accordance with the strength of the motion of the region of fire ... Its influences appear in proportion to (the time of) its stay (i.e., the larger it appears, the greater its influence as to good or bad luck to the country). In the writings of the ancients nirangs (incantations) for (counteracting) these influences are mentioned more than can be described. (Beveridge, 1897–1939, Volume III: Chapter XL).

Abū'l Faẓl also refers to Ptolemy, who said that comets presented an omen that was especially unfavourable to kings.

We may wonder: what astronomy texts and other scholarly works served as Abū'l Faẓl's references? In the *Ā'in-i Akbari* (Jarrett, 1891) Abū'l Faẓl lists works of several well-established individuals in Greek and Islamic literature and science, such as Hipparchos, Pythagoras, Theon of Alexandria, Ma´sha'llah, Khawarazmi, al-Bīrūnī, Naṣīr al-Dīn al-Ṭūsī and Ulugh Beg, just to name a few. His last Hindu sources on comets would be Varāhamihira's *Bṛhat Samhitā* (CE 505) and Vallālsena's *Adbhutasāgara* (which was composed along the lines of the *Bṛhat Samhitā*, beginning in CE 1168). However, those areas of Hindu astronomy texts that deal with *ketus* (comets) are thoroughly unsatisfactory from an astronomical point of view.

4.1 The Comets of 1264, 1402 and 1433

Drawing on ancient Persian and Pahlavi texts, Abū'l Faẓl writes at length about three notable comets seen in the past, namely the hairy comet

of 662 A.H. and the tailed ones of 803 A.H. and 837 A.H. He mentions what they looked like, their angular positions from the Sun, the number of days over which they were seen, and the countries from which they were viewed. To indicate the nature of his description, rather than paraphrasing his account we quote below a long passage (after Modi, 1917: 73–74):

> Out of all (these comets) one hairy comet appeared in the year 662 Hijri. The increaser of the splendour of the world (*Farugh afzāe-i-ālam*) was in the sign of Leo and had gone about 11 fingers[2] down the earth (i.e., had set) in the night. The strange thing was, that it (i.e., the comet) appeared to be of the proportion of the head of a big man and emitted steam from its front. It passed (i.e., appeared) in the countries of Tibet, Turkestan, China, Kashgar, Fargana, Ma'wara'u'n-nahr (Transoxania) and Khorasan. It appeared for 85 days. In all these countries, there arose rebellions. In Transoxania and Khorasan, calamities of thunder[3] and lightning and such other (phenomena) appeared.
>
> Many years and months had passed over this event, and then, in 803, a tailed comet appeared in the zenith at Rum (Constantinople). Mulana Abdallalasan and Mahiad-din Magrabi with other astrologers of that time informed Timur, that from what the wise and the experienced have said it appears that an army (coming) from the direction of the East will be victorious in that country, and a general from that country will assist (him). Timur (lit. that illuminator of the face of fortune), who was always expecting an invasion of the country, but whose companions of poor intelligence did not acquiesce, attended to that (prediction) and convinced the great and the small (of his court) of the truth (lit. gem) of his resolution and of the insight of the star-seers.
>
> In the year 837 on the occasion of a new moon in the first part of Libra, a tailed comet appeared (lit. gave brilliancy to the day) near the 17th lunar mansion in the north. It rose and set with it. After the lapse of several days, its special motion appeared. From that 17th lunar mansion in the north (a form like that of) a lance-holder separated (lit. assumed the face of separation), and in 8 months, took the path of the camel. A great pestilence, spreading misery (round about), appeared in Herat and its dependencies. Every day more than a thousand persons died. Mirza Ibrahim, the governor of Fars and Mirza Bysangar Arghun, the King of Badakshan, and Shaikh Zai-ud-din Khafi died in this calamity. A fierce quarrel, which took place between Mirza Shah-rokh and Sikandar Kara Yusaf, was also the consequence of this (comet).
>
> The learned in the mysteries of the Heavens are convinced of this, that, if it appears within the boundaries of a country, its king or its vice-regent dies. If it is declined towards the boundary, the property, *i.e.*, the country of the governor passes away from his hands, and plague and diseases and afflictions add to the sickness of the country. Sudden deaths occur among the common people …

The three Great Comets of 662 A.H., 803 A.H. and 837 A.H. are identifiable and are now designated as C/1264 N1 (perihelion on 20.29 July), C/1402 D1 (21 March), and C/1433 R1 (8.27 November). There are no records of any of these comets from India. About the first Great Comet, Abū'l Faẓl says that it was sighted while the Sun, then in Leo, had set. About the Great Comet of CE 1402, he has no astronomical information to share, while the Great Comet of CE 1433 in Abū'l Faẓl's account also figures in two Muslim texts of CE 1442 and 1524 from Egypt, where it is mentioned as a shining star with locks of hair having a 9º long train stretching eastwards (Cook, 1999: 150, Kronk, 1999: 268). It was discovered by the Chinese, in *Teen Tsang* (θ, ι, and κ Boötis) on 15 September, high in the evening sky and with a 10° tail (Wlliams, 1871: 76). It also was observed from Korea, Japan and Europe. By the second week of October the comet was conspicuous as it headed southeast and passed close to the Earth.

The comet of CE 1433 interests us in view of the fact that part of Abū'l Faẓl's account of it is intriguing. This is about the phrase that the new Moon was in the first part of Libra. This also fixes the position of the Sun. The corresponding date should be 14 September 1433 (Julian Calendar), but mention of the comet setting with the 17th lunar mansion (*al iklil*) in the north does not agree with this date. For the lunar mansion and the comet to rise and set together, their positions need to be in agreement. Orbital computations reveal that this would only have happened towards the last days of the recorded sighting of the comet, namely, around 4 November.

What did Abū'l Faẓl mean when he stated

> After the lapse of several days, its special motion appeared. From that 17th lunar mansion in the north (a form like that of) a lance-holder separated (lit. assumed the face of separation)?

Either, one saw a curved dust tail developing and separating from the straight plasma tail, or the comet's nucleus split as it approached the Sun. Abū'l Faẓl's sources need to be revisited to clarify this important observation. The Muslim texts cited by Kronk (1999: 268), both from Egypt, speak of the sighting of a comet in September-October with locks of hair and a tail 9º long that pointed towards the east, but there is no mention of observations made in November. Furthermore, there is no reference to the separation mentioned by Abū'l Faẓl. Biela's Comet (3D/Biela), is the first comet that was

observed to have split when at the 1846 apparition two comets arrived together. They had a perihelion of q = 0.8606 AU, greater than that of the Great Comet of 1433.

To further confuse the issue, the account of this comet published in Beveridge's translation is different, as it mentions the neither 17th *manāzil* nor the new Moon:

> In the year 837 (1433) a tailed comet appeared in the first degrees of the Sign of Libra near the Northern Crown. It used to rise and set there. When some days had elapsed a singular movement of it took place. It became spear-bearing (*nezadār*) and went off to a distance from the Northern Crown, and in eight months it disappeared. A great pestilence occurred in Herat and its neighbourhood. (Beveridge, 1897–1939, Volume III, Chapter XL).

The first statement in this translation cannot be correct, as the 'Northern Crown' is the popular name for the constellation Corona Borealis.

5 THE GREAT COMET OF 1577

The year 1577 witnessed two, probably three comets, namely: the 1577 comet, comet 1577 II (X/1577 U1) and the Great Comet 1577 I (C/1577 V1). The first of these comets is mentioned only in Korean records that speak of a 'broom star' sighted during the period 15 July–13 August. Nothing more is known about it. Comet 1577 II is a doubtful entity (Kronk, 1999).

The third of the 1577 comets is the Great Comet that stirred viewers like none before it. One can make this out from the numerous writings on the sightings of this comet in Europe, which are listed by Hellman (1944). On 8 November the Japanese recorded its curved white tail stretching 50º. The glorious form of the comet showed up most impressively in the famous engraving by Jiri Daschitzsky that depicted its passage over Prague on 12 November 1577 (geocentric distance Δ = 0.6327 AU). This is reproduced here as Figure 3.

The Great Comet of 1577 is truly an historical one because of observations of it by the Danish astronomer Tycho Brahe (1546–1601), who saw it first on 13 November with a tail that was 2.5° wide and 22° long, settling the important question of the distance to comets (Hind, 1852). Aristotelian cosmology regarded comets as exhalations from the Earth that were ignited in the upper layers of the atmosphere. Observing from his observatory at Uraniborg on the island of Hven near Copenhagen, Brahe determined the comet's celestial position with respect to certain reference stars using large quadrants that had a precision of four arc minutes, and compared these positions with those obtained at around the same time by another observer, Hagecius, who was 600 km away in Prague. Brahe show-

Figure 3: The woodcut by Jiri Daschitzsky showing the Great Comet of 1577 (Wikimedia Commons).

ed that the comet had an inappreciable horizontal parallax, of <15 arc minutes. This indicated that the comet's distance was in excess of 230 Earth radii ($R_\oplus$), which is approximately four times the distance to the Moon (LD). According to Brahe, the distance to the Moon was 52 $R_\oplus$; Ptolemy's value for the maximum distance to the Moon, as given in the *Almagest*, was 64 $R_\oplus$; the modern value is 63.821 $R_\oplus$. On 13 November 1577 the Moon actually lay at 60.4 $R_\oplus$, and the comet at 250 LD. Upon determining the parallax Brahe was able to argue that (1) comets lay beyond the atmosphere of the Earth, and (2) they followed circular paths between the orbits of the Moon and Venus. He professed a geocentric Universe, where the Moon and the Sun orbited the Earth, and Mercury and Venus orbited the Sun. This view was contrary to the established worldview. In 1578 he wrote a treatise in German on comets, including the one of 1577, and his views became known more widely when his book, *De Mundi*, was published in 1588; this also included the Tychonic Universe (see Yeomans, 1991). Tycho Brahe did not accept Copernicus' concept of the Universe, but his assistant, the great German mathematician and astronomer Johannes Kepler (1571–1630), did. Kepler saw the Great Comet of 1577 from a hilltop where his mother had taken him when he was just six years of age (Hudon, 2009). In 1600 he joined Tycho Brahe in Prague at the latter's invitation, and eventually inherited a large body of valuable observational data that Brahe had collected over the years.

According to A.G. Pingré, the Great Comet of 1577 was first sighted in Peru on 1 November at dusk as a very bright object that "... shone through clouds like the Moon (–7 mag)." (Vsekhsvyatskii, 1964: 106). For an evening observation, the UT of the observation based on the calculated orbit is 2.0 November (Kronk, 1999: 317). By then the comet had already passed perihelion (at q = 0.1775 AU), which occurred on 27.448 October UT, when it was even inside Mercury's orbit. With i = 104°.883, its motion was retrograde, and its orbit was near vertical with respect to the plane of the ecliptic. On 8 November, the comet was described in Japanese texts as being as bright as the Moon and with a tail ~50° long. Chaim Vital, who observed the comet from Safed in Palestine in the evening, when it was in the southwestern sky, described it as a large star with a long tail that pointed upwards. Part of the tail pointed eastwards too. It remained visible for the next three hours, and then was observed for fifty nights. According to Silverman (2008: 123), the Jewish date of Vital's observation was the first of Kislev in the Jewish year 5338, which corresponds to 11 November in the Julian Calendar. Since the Jewish day begins at sundown and the observation was made in the evening, he suggests that the date of first observation was 10 November. On 28 November, Cornelius Gemma in Belgium noticed that the comet had two tails. The comet passed closest to the Earth on 10 November (0.6271 AU), and it was last seen on 26.8 January 1578 (Kronk, 1999). Until then, it continued to trail the Sun (Full Moon on 26 October, 25 November and 25 December 1577, etc.). Comet C/1577 V1 is included in Yeomans' list (2007) of Great Comets, and according to him it reached a maximum magnitude of –3 on 8 November.

6 ABŪ'L FAẒL ON THE COMET OF 1577

In the *Akbarnāmā*, in the part relating to the expedition of the Emperor from Rajasthan to the Punjab, Abū'l Faẓl records the appearance of a comet in the twenty-second year of Akbar's reign (i.e. 985 AH):

> In the matter of the appearance of a tailed comet which appeared after sunset (lit. after the time of the sitting of the great luminary which bestows favours upon the world on the chair of the crust of the earth).
>
> A thousand thanks to God, that, owing to the benedictions of the holy soul of the King (Akbar), (bad) influences and misfortunes have disappeared from his dominions. If, in case, such a terrible sign (i.e., a comet) appears, a great calamity does not overtake this country. In spite of such Divine protection, that intelligent person of the assembly of information (i.e., the intelligent and well informed King Akbar), ordered alms to be distributed on a large scale according to the customs of the Mahomedans and Brahmans, and people of all places became cheerful. The most beautiful thing of this great liberality (i.e., the result of this alms giving) was this …
>
> On the day Arad (Arshisang), the 25th of the Ilahi month Aban, at the time when the sun made his conspicuous appearance in the sign Scorpio, this heavenly sign (i.e. the tailed comet) kindled its brilliant face in the sign of Sagittarius, faced towards the west (and) inclined towards the north. It had a long tail. It had reached such a limit, that in many towns they saw it for five months … (Modi, 1917: 70, 74).

During the Emperor's journey from Ajmer to the Punjab, he camped at Mahrot (now Marot, in Nagaur district) on the 9th of Ābān, at Amber (now Amer, part of the present-day Jaipur) on the 27th of Ābān, and so on, passing subsequently through Kot Putli, Narnaul, Delhi and other centres. Thus, the comet was first noticed before the Royal entourage reached Amber. Abū'l Faẓl does not mention if Akbar also had observed it, although it is recorded that his attention was drawn to it. Around this time of the year the rainy season is normally over, so one can presume that the sky would have been

clear. As the Sun set, and with only a few days until New Moon, the Great Comet would have been a magnificent spectacle in the evening sky, where Mercury and Saturn shone at ~14º and ~34º above the horizon respectively. At this time, Venus was a morning object.

In 1582 Emperor Akbar proclaimed a new religion, *Dīn-i Ilāhī* (divine faith), which was based on the solar year, and he also introduced a new era, the *Tārikh Ilāhī*. The *Ilāhi* calendar was Persian, or the Jalāli solar calendar, and it had Zoroastrian names for days and months that commenced at his accession, on Friday, Rabi'ath-Thani 2, 963 AH (that is, CE 14 February 1556). Abū'l Faẓl records the comet's appearance as on 25 Ābān, 22 *Ilāhi*, i.e., in the twenty-second year of the reign of the Emperor. Beveridge (1897–1939, Volume III: 310–323) gives 5 November 1577 for Abū'l Faẓl's date, whereas Mousavi (2000: 113) puts it at 7 November 1577 and Modi (1917: 83) at 10 November 1577. Modi (ibid.) notes that since Brahe's first observation was on 13 November,"... the time is well nigh the same." Let us determine the precise date.

'Ārif Qandahārī records the comet's appearance on the evening of Thursday 25 Sha'aban, 985 A.H. The corresponding (Julian) date given by Mousavi (2000: 111) is 7 November 1577, and from http://calendarhome.com/ we get Thursday 7 November 1577 at 00 UT. However, in Qandahāri's description, the phrase 'night of Thursday' means the night whose following morning is a Thursday. In that case, his observation was made on the evening of Wednesday. The likely UT of the observation is 6.5 November 1577 if he observed just after sunset.

Qandhārī's date corresponds to the Persian date 26 Ābān, 956 Panjshanbeh. Abū'l Faẓl's recorded date is 25 Ābān. The day of his observation would therefore be Tuesday and the UT of Abū'l Faẓl's observation is CE 5.5 November 1577.

The comet in the Mughal chronicles can be identified with only one object, namely the famous Great Comet of 1577, now designated C/1577 V1. It moved towards the northeast and, as Abū'l Faẓl notes, it was seen for many months and observed from several locations. For a few crucial dates, we computed the apparent position and altitude of the comet in the sky, and also that of the Sun, as viewed from Lima (Peru) and Amber (26° 58′ N, 75° 51′ E) respectively. The positions were with respect to the Earth's true-equator and the meridian containing the Earth's true equinox of date. It turns out that the comet was leading the Sun until 1 November, and it then began to trail the Sun. It was still nearing the Earth, passing its closest, 0.6270 AU, on 10 November at 04:41 UT. Being a low declination object through the period, it was easier to spot from locations far south of Europe. For instance, at Uraniborg (55° 54′ N, 12° 42′ E), where the Sun set on 5 November at about 15:00 UT, the comet lay at Alt. –02° 22′ and Az. 41° 55′ S-W. By comparison, at Amber, where the Sun set on 5 November at 12:05 UT, the comet lay at Alt. 5° 35′ and Az. 56° 04′ S-W. Its ephemeris for that day places it near the present-day border of the constellations of Scorpius and Ophiuchus. The comet must have been really bright for its altitude was only ~4º at sunset when it was first discovered on 1 November from Peru. So, even though the altitude was low on dates around its discovery, the comet was bright. In fact, it is described to have "... shone through clouds like the Moon (–7 mag.) when it was first sighted in Peru on November 1 at dusk." (Vsekhsvyatskii, 1964: 106).

Abū'l Faẓl's zodiacal system is tropical. His observation

> ... at the time when the sun made his conspicuous appearance in the sign Scorpio, this heavenly sign (i.e. the tailed comet) kindled its brilliant face in the sign of Sagittarius ...

is consistent with the computed positions for 5 November 1577 at 12:05 UT; we have the Sun at longitude λ = 233º, i.e., in the zodiacal sign of Scorpius (210º–240º), whereas the comet is at λ = 247º, in the zodiacal sign of Sagittarius (240º–270º). Against the starry background, the comet is placed right in Scorpius. In Figure 4 we depict the sky (a 45º field) where the bullseye corresponds to the comet's position as on 5 November 1577 at sunset (12:05 UT). The comet lies a few degrees south-west of Mercury. The following day, on 6 November 1577 at 12:04 UT (sunset) the comet is still within the longitudes of the sign of Sagittarius, at λ = 250º, and about 7° east of α Scorpii (Antares).

As the observations are in date order, on 5 November and 6 November 1577 respectively we have Abū'l Faẓl and 'Ārif Qandahārī among the earliest to have independently recorded the apparition of one of the most brilliant comets in history. By then the comet was a low declination object and was relatively easier to spot from southern latitudes, even the Indian region. Abū'l Faẓl and 'Ārif Qandahārī both mention that the comet was visible over a long period.

It is not known from where 'Ārif Qandahārī observed the comet. In his account in *Tārikh-i Akbar Shāhī* he describes the comet as a bright star in the west,

> ... inclining towards the south with numerous tiny stars flowing from its top, making it look like a cypress tree; it remained visible for four *ghaṛīs* (1 hour, 36 minutes) in the cities of Agra, Delhi and Lahore. It disappeared in the month of Shawwāl of the same year (12 Dec-

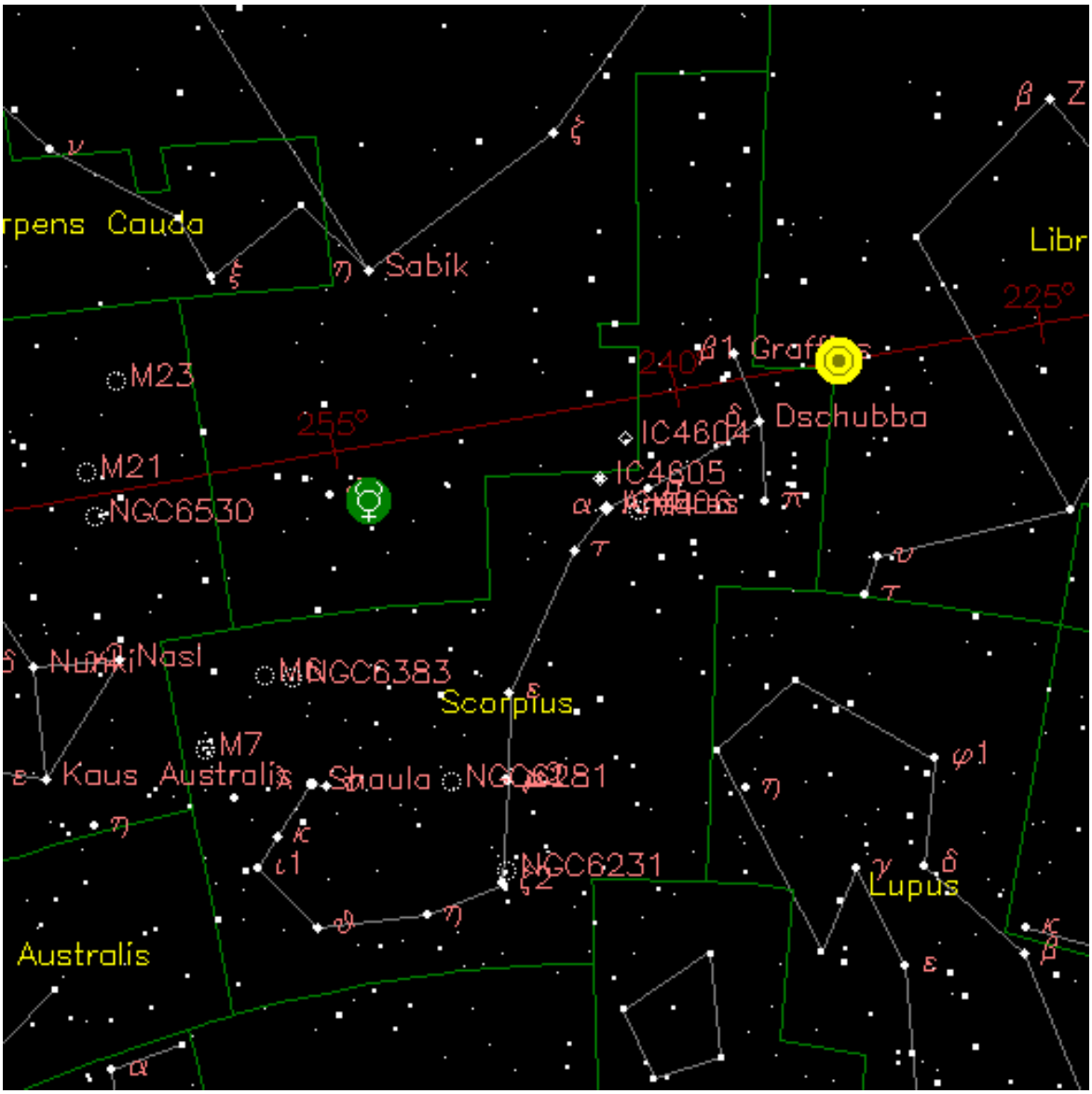

Figure 4: The Scorpius region as it appeared on Tuesday 5 November 1577 at 12:05 UT. The location of the comet is indicated by the bullseye at RA 16h 15m 01s and Dec –27° 11′ 08“ (base star map after Walker, 2013).

> cember 1577–9 January 1578) and became known as the long tailed-star (*sitāra-i dum-i darāz*). (Mousavi, 2000: 111–112).

From the information provided it looks more like an observer's description rather than a chronicler's account. Importantly, it differs from Abū'l Faẓl's description in that it records the inclination towards north.

In contrast, Nizām ud-Din and Badāūni just chronicle the event, but they also introduce the apocalyptic angle. Nizām ud-Dīn, the author of *Tabaqāt-i Akbarī*, records that the comet appeared in the twenty-third year of the reign of the Emperor Akbar, and he describes it as follows:

> At this period, at the time of evening prayer, a comet appeared in the sky towards Arabia, inclining to the north and continued very awful for two hours. The opinion of the Astrologers was that the effects would not be felt in Hindustan, but probably in Khurasan and Irak. Shortly afterwards, Shah Ismail, son of Shah Tahmasp Safawi, departed this life, and great troubles arose in Persia. (Elliot, 1873: 407).

Shāh Ismā'īl was assassinated on 14 Ramẓān, 985 A.H. (25 November 1577). While presenting Nizām ud-Din's narration, Modi (1917: 76) makes one correction to Elliot's translation: for 'dar-tari-i', instead of 'towards the East' he claims that it actually means 'towards Arabia'. That also would imply 'towards the West', for Arabia is to the west of India, which is consistent with Badāūni's and Abū'l Faẓl's descriptions, "... as appearing in the West." He also cites Elliot's explanation of how Nizām ud-Din incorrectly placed the appearance of the comet in the twenty-third year when it should actually have been the twenty-

second year.

Badāūnī's *Muntakhab-ut Tawārīkh* is a general history of the Muslim world, recorded in three volumes and beginning with Bābur. In Volume II, which deals with Akbar's reign until the 40th year, or CE 1594 (Majumdar et al., 2007), Badāūnī describes the appearance of the comet in 1577:

> And among the events of that year was the appearance of a comet in the west. And, when Sháh Mançúr took to wearing a long tail to the back of his turban, they dubbed him 'The Star with a tail'. And through his excessive economy and stinginess in the army expenses, and the pitch that he reached in grasping in season and out of season; people forgot the tyrannies of Rájah Muzaffar Khán and kept heaping upon him abundance of abuse:—"For many bads are worse than bad" ... And this same year news arrived that Shāh Ismail, son of Shāh Tahmāsp, Emperor of Persia had been murdered ... And the effect of the comet in that country became manifest, and in Irāq the greatest perturbation resulted, while the Turks conquered Tabriz, Shirwān, and Māzandarān … (Ranking et al., 1889: 240–241).

In Modi (1917: 76), the description is a little different:

> Among the unexpected events (one) was this, that in the same year, a comet appeared from the direction of the West. When Shah Mançur left a long tail from behind in the corner of his turban, they named him (in joke) 'a tailed comet.' ... The effects of this comet appeared in that country.

Badāūnī rightly places the event in the twenty-second year of the reign of the Emperor Akbar.

7 CONCLUDING REMARKS

The Great Comet of 1577 (C/1577 V1) initially generated curiosity, but this soon turned to awe owing to its brilliant form and its persistence in the night sky. Abū'l Faẓl devoted long passages in the *Akbarnāmā* to a discussion of comets in general, apparently prompted by the spectacular appearance of the 1577 comet. He specifically mentions that the Sun was in Scorpius at the time, and Figure 4 shows that the comet also was in Scorpius, although tropically it was not. In Islam, the sign of Scorpius is regarded as evil, and it forewarns of affliction to the populace. Was the comet's sidereal position responsible for Abū'l Faẓl's apprehension about this apparition?

An examination of Akbar's horoscope as discussed in the *Akbarnāmā* is appropriate here. He was born on 15 October 1542, and the moot point is whether this was under the sign Virgo or under Leo. Akbar's horoscopes were cast at the time of his birth according to the Indian sidereal system by a 'Jotik Rai' (possibly a title, not a name) and by Maulāna Chānd who was present outside the birth chamber to determine the exact time of the birth. He had used a Greek astrolabe to take altitudes and Ulugh Beg's *Gurgani* tables that were computed for 1437. Maulāna Alyas cast the horoscope on the basis of the *Ilkhani* tables of Naṣīr al-Dīn al-Ṭūsī (CE 1201–1274). Maulāna Chānd put the ascendant at the time of Akbar's birth at 7º in Virgo, whereas Hindu astrologers placed it in Leo. In Islamic and Hindu astronomy, the Sun is the lord of the sign Leo, and this sign is most appropriate for emperors.

It is worth reading Abū'l Faẓl's discussion about fixing the sign under which Akbar was born, which takes into consideration the movement of the zodiacal system by 17º in the span of 1,190 years before Ulugh Beg (as a result of precession), since this was not allowed for in the Indian calculation that fixed the birth under Leo. Also interesting are Beveridge's (1897–1907, Volume 1: 125–128) notes on this matter. Abū'l Faẓl's preference was for the tropical system, and he brought the discrepancy to the attention of the scholar Amīr Fatḥullāh Shīrāzī (who had joined Akbar's court in 1583), and asked him to resolve this matter. The latter then cast a fresh horoscope according to the Greek and Persian rules. Using older star tables that dated to around CE 830 gained him ~8.5º, and he was able to successfully place the ascendant in Leo. Abū'l Faẓl regarded this horoscope as the most reliable one.

As for the comet of 1577, it was in Sagittarius when first sighted. However, a few days earlier it would have been in Scorpius. On 3 November at 15:00 UT it transited into Sagittarius, as it constantly moved in ecliptic longitude. Abū'l Faẓl only spotted the comet two days later but, noting its motion, he would have realized where it came from. The Emperor, for his part, took the comet apparition very seriously, and he asked his minister, Rājā Todar Mal, for astrologers to explore the possible consequences of such an apparition, and he ordered alms to be distributed on a large scale as per the customs of the Mohammedans and Brahmans. Nizām ud-Din and Badāūni readily placed blame on the comet for many untoward incidents that occurred nearby and afar. Abū'l Faẓl, however, tried to minimize the perceived adverse impact of the comet by underlining that it was through the benedictions of the Emperor that the country was spared any calamity. The reasons why he did this are not difficult to guess. The traits of a natural philosopher clearly show in the treatise, but it would seem that Abū'l Faẓl was unaware of the most important aspect of his record—that he was an independent discoverer of what would prove to be one of the Great Comets of history.

Curiously, the Great Comet of 1577 brought calamity to astronomy in Istanbul. In the wake of its occurrence, certain horrifying incidents occurred, which prompted astrologers to destroy Taqī al-Din's astronomical observatory, which had only been constructed in 1575 (Heiderzadeh, 2008).

Finally, we should note that although Abū'l Fazl speaks about many past comets in the *Akbarnāmā*, he does not mention the appearance of a bright new star in the constellation of Cassiopeia only a few years earlier. This was the historic supernova of 1572, which became popular as 'Tycho's Nova' (see Stevenson and Green, 2002). It quickly rose in brightness, eventually matching Venus, and even was visible during the day-time.

8 NOTES

The following notes belong to the passage we have quoted here, on page 253, which is from Modi (1917: 73–74).

1 Most dates listed in this paper follow the Gregorian Calendar and are years CE or BCE. However, some dates, like this one (963 A.H.), are given using the Hijri or Islamic Calendar, which is a lunar calendar that consists of 12 months in a year of 354 days. The first year (1 A.H.) of the Hijri Calendar began in CE 622, when Muhammad moved from Mecca to Medina. The current Islamic year is 1437 A.H., and in the Gregorian Calendar it runs from approximately 14 October 2015 to 2 October 2016.

2. A 'finger' was a unit of measurement and equalled ~1°.

3. Taking the word to be *ra'd*. The Bengal Asiatic Society's text gives the word as the last star in the tail of the Lesser Bear. It also means a governor. But these words seems to have no proper meaning here. In the footnote to this quotation it gives rāyad as found in another manuscript, but I think that it is mistaken for ra'ad, which suits well with the next word, barāk ('flashing'). Note that the original quotation footnote 2 also has ra'ad, rāyad and barāk in the Persian script.

9 ACKNOWLEDGEMENTS

I am grateful to the Director, Indian Institute of Astrophysics (IIA) for facilities and to Drs Christina Birdie and A. Vagiswari, and Library Staff at the IIA, for their help with accessing various references. Finally, I am grateful to Professor Wayne Orchiston for helping improve the presentation of this paper.

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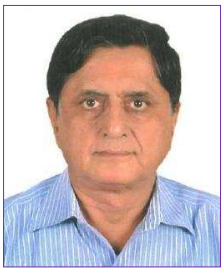

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