Journal of Astronomical History and Heritage, 22(2), 273–293 (2019).

ON TWO SEVENTEENTH CENTURY PERSIAN PAINTINGS DEPICTING COMETS OR FIREBALLS

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Abstract: In the Theodore M. Davis Collection of the Metropolitan Museum of Art in New York there are two seventeenth century Persian paintings by Muhammad Zaman and Ali Quli Jubbahdar that depict comets or fireballs. From the inscriptions on them, the paintings were dated and on that basis the comets identified as those seen in the years CE 1664/1665 and CE 1674/1675 respectively. I find these identifications in error and suggest instead the bright comet of CE 1652 and the Great Comet of CE 1668 as the probable ones or that both paintings actually depict fireballs rather than comets. Both the paintings depict celestial objects with tails, and are most likely based on astronomical observations. Such a connection between astronomical knowledge and art was not common in the Middle East and India during the Medieval and Early Modern Periods.

Keywords: Comet of 1652, Great Comet of 1668, fireballs, astronomy in art, Medieval Persian paintings, Farangi-Sazi, Muḥammad Zaman, ʾAli Quli Jubbahdar, astronomy in seventeenth century Persia

1 INTRODUCTION

In the Theodore M. Davis Collection of the Metropolitan Museum of Art in New York (The Metropolitan Museum of Art, 2018), there are two paintings, namely 30.95.174, fol. 1 and 2, attributed to two prominent Persian painters of the seventeenth century, namely, Muḥammad Zamān and ʾAlī Qulī Jubbahdār respectively, which depict what appear at first sight to be comets. The paintings belong to the Safāvid Period (CE 1501–1722) and are beautiful representations of tenebrism in art.[1] Muḥammad Zamān was the premiere exponent of an exotic mode of painting, termed the *Farangī-Sāzī* (in the European style), that introduced a blending of European visual style in the late Safavid period painting tradition, and "… was developed by artists around the 1630s." (Landau, 2011: 103). For ʾAlī Qulī Jubbahdār, the other painter, Zamān's style was an inspiration. The respective descriptions of the paintings as given in its website by The Metropolitan Museum of Art (2018) and in Landau (2011: 101–131) are very informative and also identify the comets—the ones seen in the years CE 1664/1665 and CE 1674/1675, respectively. Upon cross-checking, I find that the comet identifications are not correct and suggest plausible alternatives. For the trends of the times the subject matter in the paintings is exceptional. Therefore, a look at these in the context of seventeenth century Persia's exposure to neo-scientific knowledge of the West will be instructive. As its capital since 1598, Isfahan was then the central engine of Persia and the Empire's gateway to the west, north and the east.

2 THE PAINTING BY MUḤAMMAD ZAMĀN

The painting entitled *A Nighttime Gathering* attributed to Muḥammad Zamān ibn Ḥājī Yūsuf (fl. 1649–1700; Landau, 2009; The Metropolitan Museum of Art, 2018) is shown in Figure 1. It is ascribed as 30.95.174 Fol. 1 in the Davis Album and is chronologically the earlier of the two paintings under discussion here. At the very top of the painting it shows a starry night with a comet or fireball in the sky, while below a *mullah* and an old man confer, with books lying in front of them. Standing beside them is a prince or a nobleman and his counsel (an astrologer?), with a book in hand listening to the conversation. The dress and the looks suggest the princely figure to be an Indian. He is looking askance, tense and frustrated, while his armed guard watches. There are three people in the distance, probably the prince's retinue or locals, also looking at the celestial object. A less conspicuous structure in the distance, possibly a dwelling, also is depicted. The hillside in the top left part of the painting is delineated with a cluster of dwellings. The root cause of the prince's worry is the possible fallout from the evil visitor in the sky. His learned counsel could not dispel it and so, no matter the language gulf, the prince is here to seek advice and take remedial measures if necessary. The painting is signed and dated "in the year 7". There is no Hijri year inscribed and that is odd. According to The Metropolitan Museum of Art (2018), the painting may have been done in

> … the seventh regnal year of the Mughal emperor Aurangzib (i.e., 1665) … [and] may record the first of two comets sighted in the northern hemisphere in December 1664 and April 1665 …

and the painting may have been produced in Eṣfahān (Isfahan) or in India.

The date on the painting was interpreted as referring to Aurangzeb's period when the Safāvid King Shāh Abbās II ruled (i.e. 1642–1666 CE; Matthee, 2014), which is rather puzzling. It is true that in the 1640s, many Isfahani painters were inclined towards the Mughal and the *Deccani* style of painting and

Figure 1: *A Nighttime Gathering*, by Muḥammad Zamān; Theodore M. Davis Collection, Bequest of Theodore M. Davis, 1915, Accession Number: 30.95.174.2 (Source: The Metropolitan Museum of Art; accessed 05.08.2019).

drew inspiration therefrom (see Farhad, 2014). Aurangzeb (b. 1027 AH/1618; r. 1658–1707) ascended the throne on 1 *Dhu-al-Qa'dah* 1068 AH (Elliott, 1877: 229; ≡ CE 31 July 1658 Greg). The 7th year of his reign was 1074 AH (Elliott, 1877: 271). The corresponding Gregorian dates for this year are 1 *Muḥarram*–30 *Dhu-al-Ḥajjah* 1074 AH (or CE 5 August 1663–24 July 1664). It should be noted that beginning on 8 December 1662—the sixth year of his reign—Aurangzeb went on an expedition to Kashmir, after a sojourn in Lahore. The Italian traveller and writer Niccolao Manucci (1639–1717) who worked in Aurangzeb's court also travelled to Kashmir with the Emperor's entourage.[2] Aurangzeb returned to Delhi on 18 January 1664 (Julian; Sarkar, 1921: 7), i.e., in his seventh regnal year. How could the painter have related his work to the Mughal Emperor's seventh regnal year when the comet of December 1664 was yet to appear? This comet was discovered on 17.9 November in the morning, from Spain (Kronk, 1999: 350).

No comet in recent memory, not even that of 1661 which was seen in February-March in the morning and with a tail of less than 6°, would tally with the depiction in Zamān's painting of what appears to be a late evening situation, since the comet's head faces south-west. In the modern cometographies, the only comet worthy of a mention prior to that of December 1664 was the one that appeared in December 1652 (C/1652 Y1).

That comet was discovered by Jan van Riebeeck (1619–1677) from the Cape of Good Hope on 16.8 December in the evening in the east-southeast. It was a low declination object when discovered, and lay to the south of the "… head of Orion [i.e. λ Ori], about 80° above the horizon." (Kronk, 1999: 346). A naked eye object, it was observable for three weeks, and its tail extended at most 6–8° (Vsekhsvyatskii, 1964: 114–115). In his *Cometographia* the experienced Polish observational astronomer Johannes Hevelius (1611–1687) shows it as having a straight tail (BnF, 2018), while Pingré (1784: 9–10) wrote:

> This Comet, of a pale and livid colour, equalled almost the Moon in grandeur, at the judgment of Hevelius & Comiers. It has been observed by many astronomers since the 18th of December 1652 until the first days of January 1653.

On 16 December, the comet had reached quite close to the Earth (0.15 AU) and was moving rapidly north-west. On 19 December, it passed closest to the Earth at a distance of 0.1284 AU. It would have been at its brightest then. After its discovery on 16 December in the constellation of Puppis, the comet passed through Lepus on 18 December, Eridanus on 20 December and Orion-Eridanus-Orion-Taurus on 21 December. Moving northwards, it crossed the equator the same day. On 24 December, it passed 1° from the Pleiades when the comet's tail, according to Arcetri observers (Kronk, 1999: 347), was at its brightest.

A comment on the night sky as depicted in Zamān's painting is in order. Compared to Jubbahdār's painting where the comet or fireball is depicted more like the way it may have been seen, the trail of the object in Zamān's painting is horizontal and quite extended. Figure 2 is an enlargement of the upper section of Figure 1, and although no particular stellar configurations can be identified with certainty, there is a pattern of the stars that vaguely resembles the constellations of Canis Major (*Ṣūrat al-Kalb al-Akbar*) and Orion (*Ṣūrat al-Jabbā*). We do not know if Muḥammad Zamān actually saw the comet of December 1652, and if he did and painted it whether he went so far as to reproduce the night sky. We can only say that he had a certain familiarity with the night sky, even though he was not an astronomer.

Taking this discussion a little further, the two bright spots on the trail in Figure 2, from left to right, could depict Aldebaran and the Pleiades respectively. The painting then portrays the situation when the comet of 1652 was passing the Pleiades, as observed on 24 December. This scenario is possible, but it leaves us asking: How can the sky be bright in the south-east if sunrise is still more than 3 hours away? That situation would have occurred about 3 months earlier, say in September of 1652. But there was no naked eye comet around then, and the starry background would have been different.

What sky references were available in Zamān's times? He could have used an Islamic celestial globe or a star chart adjusted to a recent epoch. Celestial globes were generally based on the star atlas by the Persian astronomer Abū al-Ḥusayn ʿAbd al-Ṛaḥmān ibn ʻUmar al-Ṣūfī (CE 903–86; Hafez, 2011). His atlas *Kitāb Ṣuwar al-Kawākib al-Thābita* (*Book of the Fixed Stars*), originally in Arabic (CE 964), was a highly influential book (Hafez et al., 2011; 2015a; 2015b). It described Ptolemy's forty-eight constellations. Most interestingly, the constellations were depicted in mirror images—one as seen on a celestial globe (*al-kura*), and the other as seen in the sky (*al-Samā*).

The configurations of the constellations of Orion and Canis Major as in a manuscript of al Ṣūfī's atlas of 400 A.H. (CE 1009–1010) are reproduced here in Figures 3 and 4 (BnF, 2019) to give an idea of what lay in store for an artist wishing to depict them. Al Ṣūfī's book was used as a standard reference work throughout the

Figure 2: An enlargement of the top portion of Zamān's painting in the Figure 1.

whole of the Islamic world; it was frequently copied and translated, in Persian and later in Latin. In the course of his PhD research, Ihsan Hafez tracked down 35 different copies of al Ṣūfī's book in various repositories in Denmark, Egypt, England, France, Germany, India, Iran, Italy, Lebanon, Qatar, Russia, Spain, Tunisia, Turkey, and the USA (see Hafez et al., 2011: 128). The Bibliothèque Nationale de France has in its possession the late sixteenth century copy of the Persian translation by Naṣīr al-Dīn al-Ṭūsī. There was another translation done in the early seventeenth century by Ḥasan ibn Ṣa'd al-Qā'īnī (van Gent, 2018). Notably, in India, Luṭfullāh Muhandis also translated it into Indo-Persian at the advice of his father, Aḥmad Ma'mār, the architect of the Taj Mahal (Professor Razaullah Ansari, pers. comm., 2018). Brentjes (2013: 489) mentions illustrated copies of al Ṣūfī's book prepared in Persian in 1630 and 1634 in Mashhad, and copies in Arabic dating to about the same period.

It may be said that al-Ṣūfī's monumental work was read not only by astronomers or students of astronomy but also by calligraphers and painters, because its illustrations and figures would have been drawn by artists (Mohammad Mozaffari, pers. comm., 2018). Through the many successive editions, the illustrations underwent variations. As these depicted the constellations individually, it would be difficult for one who was not a frequent observer of the sky to recreate a starry configuration by just consulting the illustration or the arrangement on a globe. That may have been a problem for Zamān when he did his painting.

3 THE PAINTING BY ʾALĪ QULĪ JUBBAHDĀR

ʾAlī Qulī Jubbahdār was Muḥammad Zamān's contemporary and active from 1642 until late in the seventeenth century (The Metropolitan Museum of Art, 2018). According to Negar Habibi (2016: 147; 154),

> The first painting signed ʾAli Qoli Jebādār is dated 1069/1658-59 … 'Babur kissing [the hand of] Shah Ismail', executed on the order of Shah Abbas II … [and] the last painting signed is probably the folio 93 recto of the Muraqq'a of St. Petersburg dated 1085/

Figure 3: The constellation of Orion in al-Ṣūfī's treatise *Kitāb Ṣuwar al-Kawākib* (*al-thābitah*) (400 A.H.), as seen on a celestial globe (right) (folio 133v) and in the sky (left) (folio 134r), "Source gallica.bnf.fr / BnF" (BnF, 2019; accessed 05.08.2019).

> 1674-75, representing two European ladies … In the 19 years between these two dates, at least 10 other paintings are signed ʾAli Qoli Jebādār. Presenting various artistic techniques, these paintings show also a remarkable thematic diversity … Since we do not have any more dated and signed works by the artist after this date … it would seem more plausible that the career of ʾAli Qoli Jebādār, or at least his time of high activity, is estimated at 26 years between 1059/ 1649-50 and 1085/1673-74.

Jubbahdār's painting in the Davis Album, *Two Old Men in Discussion Outside a Hut* (*30.95.174 Fol. 2*), is shown in Figure 5. It depicts two old men, probably astronomers in conversation and in the sky, there is a comet or fireball with a long trail. There is also a bright star, way down near the horizon. As in Zamān's painting, here too the artist's stance is reverential to the old as men of knowledge. On the painting the name *Alī Qulī Jubbahdār* and the date *1085* are inscribed (Landau, 2011: 115). The Metropolitan Museum of Art (2018) describes it as based on *A Nighttime Gathering* by Muḥammad Zamān "… whose distinctive style – farangi-sāzi (European mode), was influential in the late seventeenth century."

In 1972 Robert Skelton (Landau, 2011: 128) first drew attention to what he saw as a comet

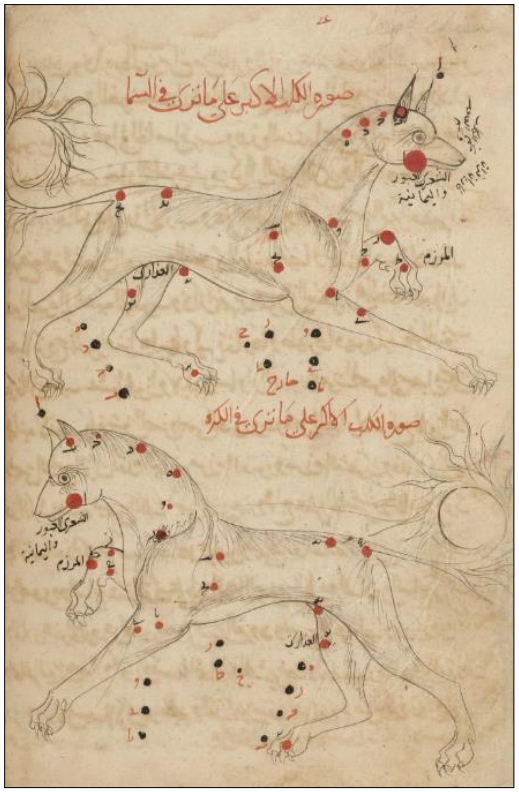

Figure 4: The constellation of Canis Major in al-Ṣūfī's treatise *Kitāb Ṣuwar al-Kawākib* (CE 1009), "Source gallica.bnf.fr / BnF" (folio 143v, BnF, 2019; accessed 05.08.2019).

Figure 5: *Two Old Men in Discussion Outside a Hut*, by ʿAlī Qulī Jubbahdār; Theodore M. Davis Collection, Bequest of Theodore M. Davis, 1915, Accession Number: 30.95.174.3 (Source: The Metropolitan Museum of Art; accessed 05.08.2019).

in the painting, and he said that the depiction was of the one that had appeared in the year 1085 AH (1674–1675). However, this identification is in error, as there was no comet visible in the year 1085 AH, or, at any time in CE 1674 or 1675 for that matter. Therefore, the depiction could be a recall of some other comet, possibly a recent one, or of a fireball. Comets recorded just prior to the above date are those of 1672 (C/1672 E1) and of 1673 (Kronk, 1999: 362–364). These comets *were* noticed, but with tails stretching to ~1°, they do not fit the depiction in the painting. Could it be a comet that appeared still earlier? The way the object is depicted suggests it to be an evening observation because then a comet would normally have its head roughly towards the west. Also, the depiction is about the phase when the comet must have been really bright.

Prior to the year 1674, the recent comets that became spectacular at some point of time had appeared in 1664, 1665 and 1668. These were noticed for their long straight tails. The comet of 1664 (C/1664 W1) was discovered on 17.9 November as a morning object. It became spectacular towards the end of December when it showed up with the greatest tail length during 23–27 December, reaching 35° (Kronk, 1999: 353). A few days later it was seen in the evenings. In Isfahan, it would then have been visible to the south after midnight. However, around then the light of the waxing Moon was beginning to affect the view, with Full Moon on 2 January 1665. There is no impression of this in the painting. Besides, the observed tail orientation may not have been the same as that in the depiction.

By the same consideration, the comet of 1665 (C/1665 F1) does not fit: it was discovered on 27.8 March as a morning object with a tail that had extended up to 17°.

In contrast, the comet of 1668 (C/1668 E1) was an evening object. It was discovered on 3.8 March. It was in fact a Sungrazer, with perihelion q = 0.0666 AU and motion direct, that passed perihelion on 28.08 February UT. The comet reached a maximum magnitude 1–2 on 8 March (Yeomans, 2007). It had a tail 23° long on 5 March and 32° on 12 March. As noted by Proctor (1926: 161), the comet of 1668 was perhaps as remarkable in splendour as the Great September Comet of 1882 (C/1882 R1). Maraldi (1711: 102), in a communication on the context of the comet of 1702, mentioned that the comet of 1668 was seen in Isfahan and written about in Chardin's report, as also in San Salvador and the Cape of Good Hope, etc.

Is *this* the comet in Jubbahdār's painting? The fact is that ruling out a comet is far easier than establishing one. So, we need to delve further. The painter did have some basic idea of the sky but was not an astronomer *per se*. That is the reason the sky-depiction renders the unravelling difficult. For a painting being done in 1674–1675, Jubbahdār might have before him the apparitions of 1672 and 1673 but he would remember more the Great Comet of March 1668 that became a subject of discussion among the astronomers and was long 'the talk of the town'.

In Jubbahdār's painting when enlarged one can find a lone bright star way down in the right-hand corner. The star might not be Achernar (*α Eridani*, southern declination –59° in 1668). With no other bright object in the background, our choice falls on Jupiter or Venus. The view in the painting does not include the Moon. As the New Moon was on 12 March, we may take it that the sky corresponds to an evening earlier than that of 13 March. The planet Venus was not only in the evening sky but at comfortable altitudes above the western horizon when the comet of 1668 was passing through its brilliant phase soon after its discovery. A computation made for 8 March at 15:00 UT places the comet's head 16° from Venus and on 12 March at 19°. However, with no further information available, this is as far as we can go.

4 THE 'IN THE YEAR 7' IMPASSE

The comet identifications in Landau (2011) and The Metropolitan Museum of Art (2018) rested on two premises. Firstly, the date *sana 7* as inscribed on Zamān's painting may be referring to Aurangzeb's seventh year of reign, which places it at the time of Shāh Abbās II. Secondly, on the time axis, Jubbahdār's painting (of 1085 AH) dates later than Zamān's. About Zamān, Landau (2011: 122) says:

> Although we have no documented dated evidence that Muhammad Zaman was active in the 1650s when Angel was in Iran, it is indeed possible that the Safavid painter, who had a natural talent for working in a variety of artistic idioms, began his career in the medium of mural painting, where the Europeanised style seems to have first been developed, as early as the mid-1600s.

The 'Angel' above was the Dutch painter Philips Angel (1618–1664) who was in Isfahan in 1061/1651–1652 and later built a studio where he could execute his artwork. As Landau (2011: 121) further observed:

> Angel, a bold and enthusiastic spokesman for the art of painting, who was in contact with Safavid officials and at least one court painter, would have been in a good position to communicate his artistic interests, ones that he shared with Safavid painters and their patrons … Angel and Muḥammad Zamān may have even directly interacted with one another.

Later, Zamān's excellence earned him the patronage of Shāh Sulaymān (1648–1694). Here, the work he did was on the themes that were in line with the religious and political thought of the Imperial Court. In this phase of activity, nothing done by him has come to light where an astronomical concept, phenomenon or event is touched upon.

Zamān's first known work under the patronage of Shāh Sulaymān was a pen-case (*qalamdān*) done in 1673 (Landau, 2009: 123). As a part of the Safāvid tradition of illustrating and refurbishing classic Persian and Arabic manuscripts that included those on such subjects as astronomy, astrology and medicine etc., three paintings by Zamān were added to the sixteenth century copy of the literary classic *Khamsa* (Quintet) for Shāh Tahmasp (r. 1524–1576) and in the *Shāhnāmā*. These were all signed *sana 1086* or just *1086* (Landau, 2011: 101–131). Likewise, Zamān dated his biblical paintings to the 1670s and 1680s. Therefore, a reference like *sana 7* is an oddity that should rather be a record of a regnal year or one from tradition. Was it that the year 7 was counted from the death of Shāh Abbās II in 1077 A.H./1666 or better still, from the reign of Shāh Sulaymān in 1668? The latter date takes us right into the year 1086 AH around when Zamān became engaged in manuscript illustration. Should that be the case, why would he choose to portray a less spectacular comet of 1652 and not the Great Comet of 1668? The comet of 1668 qualifies for Zamān's painting but then his portrayal of the sky becomes arbitrary. The next noteworthy comets were yet to appear, i.e., in 1680, 1682 (Halley's), and so on.

However, consider this. In the Persian philosophy, the number seven has a sacred meaning. It pervades many different aspects of the Persian culture. Or, better still, the year 7 is *yūnt-īl*—the Year of Horse, the seventh one in the duodenary cycle of the Turkish animal calendar (*sanavāt-i turkī*). The calendar was resorted to in matters of taxes, book-keeping and commercial matters, etc. and the Persians used it in deeds, bonds and records etc., right until the beginning of the twentieth century. Father Raphaël du Mans (Richard, 1995: 369) notes:

> In the Royal Chamber of Accounts they use a certain old era distinguished by years bearing the names of 12 wild beasts and large animals and its vestiges borrowed from the Great Tartars, as well as their names. They believe that the influences that are exerted on this year adapt to the quality and property of the animal that governs the current year. And after a cycle of 12 years, they come back again at the beginning …

The cycle of *Twelve Animals*, common to many cultures in Asia, is used to number and designate years. In this calendar, the year commences on the day of the Vernal Equinox. Monshi (1930: II: II: x–xi) lists a few cycles of the animal years. The last *Horse Year* listed therein is 1027 AH = 1617–1618. Since the year 1027 AH is actually CE 29.12.1617–18.12.1618, we may take it that the corresponding *Year of Horse* commenced from CE 21.03.1618. The years of horse next in the cycle are those of CE 1630, 1642, 1654, 1666, 1678, and so on. The year of our interest belongs to the period 1650s–1670s. The *Year of Horse* 1678–1679 (1089–1090 AH) is rather late for the painting of interest to us. Thus, beginning on the day of the Vernal Equinox, any one of the years 1654 (1064–1065 AH) or CE 1666 (1076–1077 AH) will be the *sana 7*. As for the painting, it is difficult to believe someone preferring in 1666 a comet of 1652 over a spectacular comet of 1664 that was noticeable for over four months. The comet of 1664 was a morning object, but in Isfahan it could be seen up in the sky towards the south at midnight in late December when its tail also was of greatest length. However, this comet never passed close to Aldebaran and the Pleiades. If this comet was his choice, Zamān went horribly wrong on his astronomy and memory, something difficult to believe. The system of astronomical knowledge in Persia was sufficiently robust at this time, as evident from Father Raphaël du Mans' important observation mentioned in the *Estat de 1660* (Richard, 1995: 123–125):

> They have here the Almagest of Ptolemy in Arabic, the Spheres of Menelaus and Theodosius, several kinds of theories and means [?], movements of planets as of Coagé [Khawājah] Nescir [Naṣīr al-Dīn al-Ṭūsī] and Mirzā Ulugh Beg, all of Euclid's works, some fragments of Archimedes and Apollonius and other old authors; also the perspective of Ibn al-Haytham, the books of arithmetic, elm-e hesāb, algebra, optics, minaser [in Arabic *Manāẓir* for optics], of moving forces …

The overwhelming problem of matching the objects in the paintings with suitable comets leads us to examine another possible interpretation: that they actually depict fireballs and not comets.

5 DO THE PAINTINGS DEPICT FIREBALLS RATHER THAN COMETS?

Could the celestial objects in the paintings under discussion be fireballs or bolides rather than comets? That is certainly a possibility. Meteors brighter than the planet Venus, at visual magnitude –4 or brighter still, are called fireballs, whereas those brighter than the Full Moon, at the magnitude –14 are bolides that explode in the atmosphere. Very bright meteors shooting

across the sky can stun viewers with their suddenness, bright flickering light and sonic boom—all in a matter of seconds—and a long smoky-looking trail that can linger in the sky for quite some time. Since some of these are exceptional events they can have a long-lasting effect on the human psyche, which later can serve as the source of anecdotes about the event.

In Figures 6 and 7, taken from Olson and Pasachoff (1998; 2019), we see two interesting examples of bright meteors. Figure 6 shows a Leonid with a long trail, which was photographed on the evening of 17 November 2009. In Figure 7 there is a painting by Thomas Sandby (Olson and Pasachoff, 1998: 70–71) that depicts *The Meteor of 18 August 1783 in Three Aspects Seen from the Northeast Corner of Windsor Castle*. The artist depicts a wide straight tail that has been mistaken by some for a comet (Olson and Pasachoff, 1998: 63).

We need to see the depiction of the meteor in Figure 7 in light of the fact that this was painted at a time when nineteenth century astronomy in Europe was already on firm grounds and had a greater reach among the public—recall the prediction of the return and the recovery of Comet 1P/Halley, the two transits of Venus, the discovery of Uranus, and the sensation that all of these caused. The various celestial events inspired innumerable artists who pictured them beautifully, including much detail. Yet, comparatively speaking, depictions of fireballs and bolides in works of art were not very common. Europeans were fascinated by comets and when it came to depicting an unusual fiery occurrence in the sky the general inclination was towards a comet.

Figure 6: A Leonid fireball seen on the night of 17 November 2009 (after Olson and Pasachoff, 2019: Figure 192).

Fireballs and bolides were transient events and generally were seen by only a small localised populations. Comets lingered in the sky for much longer, and were there for all to see. Furthermore, anecdotes about comets often travelled far and wide, were long lasting and

Figure 7: A painting by Thomas Sandby depicting the fireball of 18 August 1783 (after Olson and Pasachoff, 1998; 2019).

were sometimes connected to unfavourable circumstances in life—famines, pestilence, the death of a king or the fall of an empire—and not necessarily concurrent. In some cultures, comets were apocalyptic and assigned strong astrological influence. As such, they had the potential to fire an artist's imagination.

What do the paintings by Zamān and Jubbahdār tell us? When we examine the close-up of Zamān's painting (Figure 2) we see that the tail is straight and narrow. This is what a fireball normally look like. In Jubbahdār's painting the tail also is long and straight, but no bright spots are noticeable. However, note the orientation of the people in both paintings. The old men are engaged in deep conversation, presumably about the celestial visitors, but if the latter were meant to be fireballs or bolides we would expect people to be looking at—or even pointing to—these transient objects (just as we see in Sandby's painting in Figure 7).

6 PERCEPTIONS OF COMETS AND FIREBALLS IN INDIA AND THE MIDDLE EAST

According to Aristotle (384–322 BCE), comets were dry and warm exhalations in the upper atmosphere that belonged to the sublunary sphere—see his book *Meteorologica*, which dates to about 330 BCE. This perception continued until the time of Tycho Brahe (CE 1546–1601), who on the basis of his observations of the Great Comet of 1577 was able to argue that comets lay beyond the atmosphere of the Earth and that they should follow circular paths between the orbits of the Moon and Venus. Drake and O'Malley (1960) describe how in Europe views on comets began to change dramatically in the seventeenth century, particularly in the wake of the apparitions of the Great Comets of 1577 and 1618.

How did the astronomers in India and the Middle East explain comets, meteors, meteor showers, fireballs and bolides at this time?

In the *Bṛhat Samhitā*, the Indian astronomer Varāhamihira (CE 486–587) identified three different types of *ketus* (comets), namely, celestial, atmospheric and terrestrial (Bhat, 2010: Chapter XI). Celestial *ketus* were seen amid the stars in the firmament, and although Varāhamihira described them morphologically there actually were no real comets there.

In fact, no Hindu astronomy text actually discussed comets. Nor was there a tradition in India to record comets. However, Varāhamihira included meteors and earthquakes among portents. An *ulka* (meteor) is broad at its head and has a tiny tail, but grows bigger and bigger as it descends. There were many varieties of the meteors, depending on form, colour and brightness. As a guide, a king should not march in the direction where an *ulka* strikes his town or his army, and if the *ulkas* fall from the sky in clusters, they portend the fall of the king and the kingdom (Bhat, 2010: Chapter XXXIII).

The celebrated French astronomer Guillaume Le Gentil (1725–1792) came to Pondicherry in 1768 to observe the 1769 transit of Venus and, while waiting for the event he learnt the essentials of Hindu astronomy from local Brahmins. Le Gentil noted that the Brahmins did not know anything about comets, and believed that they were signs of Heaven's wrath (Le Gentil, 1779: 42).

In the Muslim world, unexpected phenomena like eclipses, comets, meteors and earthquakes were regarded as ill omens for rulers and Emperors and so were routinely monitored by astronomers and chroniclers. Including such events in political histories was a well-established tradition in the Middle East (although it lost some momentum after about AD 1400). These unexpected events and objects terrified the people, who saw them as portents. Thus, Arab legends refer to shooting stars as firebrands that the angels hurled at the Jinns who were ever eager to peep into the Heaven (see the *Surah Al-Hijr* 15: 18 and *Surah As-Saffat* 37: 6–10).

Most Islamic astronomers held Ptolemaic views on comets and meteors, and since they were atmospheric rather than heavenly phenomena they could be ignored. But the renowned Persian astronomer, astrologer and philosopher, Ja'far b. Muḥammad Abū Mash'ar (CE 787–886), considered that comets were celestial objects (see Neuhäuser et al., 2016). Meanwhile, the Andalusian philosopher Ibn Rushd (CE 1126–1198), believed that comets could not be classed with the other stars. The tail and the comet burned with a flame and its interaction with the effluvium created a long tail (Cook, 2008: 195).

There are several records of meteor showers to be found in medieval Arab chronicles, and Rada and Stephenson (1992) have provided details of these. Arabic astronomers saw the meteor shower of CE 4 March 571 as coincident with the birth of the Prophet. As the Islamic calendar is lunar, it would not have been easy to come to regard enhanced meteor activity as being annual. In a survey of Muslim information on comets and meteors, Cook (1999: 135, 138, 146) lists several instances of bolides, while over the centuries meteor showers were noticed in many places in the Middle East: e.g., from Syria on CE 16 July 706 (the Perseids?), from Egypt on CE 27 October 901 (the Leonids?), from Iraq and Egypt in CE mid-October 1202, etc.

Kennedy (1980; 2019) has published material drawn from a book titled *Tanbīhāt al-munajjimīn* (*Admonitions to Astrologers*) by Muzaffar b. Muḥammad Qāsim Junābādī (Gunābādī). It was dedicated by the author to Shāh Abbās I (r. 1588–1629). Among other topics, the book describes the portents associated with the appearance of 'tailed stars', (i.e., comets and meteors) and certain meteorological phenomena. It also lists actual events that occurred in different places in the Islamic world, and, the sources used in compiling the book. There is even a subsection listing different kinds of tailed forms:

(1) *Nayzak* (modern Arabic for a meteor, originally a short spear).
(2) *Shihab* (a flower, firebrand, meteor).
(3) *Amud* (pillar, column, post).
(4) *Buq* (horn).
(5) *Jabiyah* (a pool, or well).
(6) *Dhu Dhawdba* (having a lock, or mane).
(7) *Dhu Dhanab* (having a tail, comet).

The actual objects listed by Junābādī are mostly comets, but there are a few bright meteors, a bolide that was seen in Sultān Maḥmud's (971–1030) time, and a new star (supernova) in CE 1006 (Cook, 1999: 142). All of these events are cited as portents.

The tradition of recording 'politically-significant' cosmic events continued for a long time, and, not surprisingly, even was found in India. Northern India was dominated by the Mughal Empire during the sixteenth and seventeenth centuries, and its chronicles record a number of solar and lunar eclipses, fireballs and comets. The emperors took the occurrence of comets quite seriously and even sought remedial measures.

A comparison with how comets were viewed in the Mughal period brings up similarities in the perceptions. Between them, the Safāvids and the Mughal Empire maintained a good relationship for a long time. The regular stream of migrants to the Mughal Empire included artists, scholars and craftsmen who also brought with them knowledge of astronomy, mathematics and natural sciences (Ansari, 2016: 583). The Royal Mughal memoirs written by courtiers provide details of the occurrence of several astronomical phenomena, namely solar and lunar eclipses, fireballs and comets. The records also bring forth the rulers' serious concerns about the auspiciousness of the serendipitous phenomena and how they sought counsel to tide over the possible consequences and even suggest remedial measures. The French traveller Jean Baptiste Tavernier (1605–1689), the Baron d'Aubonne and a jewel trader, has described how the comet of 1665 terrified the Mughal Emperor Aurangzeb (1618–1707; r. 1658–1707) who, while the comet was in the sky:

> … drank only a little water and ate a small quantity of millet bread; this so much affected his health that he nearly died, for besides this he slept on the ground, with only a tiger's skin over him, and since that time he never enjoyed perfect health. (Tavernier, 1925: 309).

Abū'l Faḍl (1551–1602), the Prime Minister of the third Mughal Emperor Jalāluddīn Muḥammad Akbar (1542–1605; r. 1556–1605), was a scholar. Citing past apparitions recorded in Middle East and West Asian sources, he provided in his highly acclaimed work *Ā'īn-i Akbarī* (*Institutes of Akbar*; in Persian, 1590) an erudite exposition on comets. He stressed that comets were related to the phenomenon of evaporation and belonged to the realm of the physical sciences. His discourse on the theories of their origin and formation was in the context of the appearance of the Great Comet of 1577 that he duly recorded in the *Akbarnāmā* (see Kapoor, 2015).

After Aurangzeb, the Mughal Empire and the Muslim rule in India in general began to totter. There were no more political histories to be written and the tradition of recording naked-eye observations of unexpected phenomena came to an end.

7 COMET AND FIREBALL REFERENCES IN SOME PERSIAN WORKS

The ancient Persians distinguished between the Sun, the Moon and the Fixed Stars as belonging to the creations of *Spenta Mainuyu* (*Good Spirit*), while the planets, comets and meteors belonged to *Angra Mainuyu* (*Evil Spirit*). The former class represented all that is orderly and systematic while the latter class is of wandering bodies. The wandering bodies were termed fairies, being of the class of creations of the Evil Spirit (Modi, 1917: 104).

The ninth–tenth century Pahlavi text *Bundahišn* (*Bundehesh*; i.e. primal creation) is an encyclopaedia of Zoroastrian theology and cosmogony. In the chapter on the planets and cosmology it says that

> Seven chieftains of the planets have come unto the seven chieftains of the constellations, as the planet Mercury (Tir) unto Tishtar, the planet Mars (Warharan) unto Haptoring, the planet Jupiter (Ohrmazd) unto Vanand, the planet Venus (Anahid) unto Sataves, the planet Saturn (Kevan) unto the great one of the middle of the sky, Gochihr and the thievish (*dujgun*) Mushpar, provided with tails, unto the sun and moon and stars. The sun has attached Mushpar to its own radiance by mutual agreement, so that he may be less able to do harm (vinas). (West, 1897(5:5): 1–2).

As stressed by Modi (1917: 101), the *Bundahišn* makes no specific distinction between comets

and meteors. The *Bundahišn* further says that

> As *Gochihr* falls in the celestial sphere from a moon-beam on to the earth, the distress of the earth becomes such-like as that of a sheep when a wolf falls upon it. (West, 1897 (5: 30): 18).

The words *mushpar* (meaning: with tails) and *gochihr* (head and tail) mentioned here refer to comets. West here takes the word *Gochihr* as referring to a meteor (Modi, 1917: 101).

Eclipses, comets, meteors and earthquakes were signs of ill omen in the Persian life too. The celestial events were related to the zodiacal signs in which they occurred (Donaldson, 2015: Ch. XII). Astrologers formed an integral part of the Royal Courts and their counsel was sought at the times of eclipses, Royal births, or for determining auspicious times before embarking on missions or marches, etc. Thus, we can understand how through the centuries the Safāvid Persia viewed serendipitous phenomena in the sky. The Great Comet of 1577 is well documented by several cultures as a grave sign of calamity. It was implicated in Shāh Ismaīl's life, the son of Shāh Tahmasp Safāwī, who was assassinated soon after the comet appeared, and great troubles arose in Persia (Monshi, 1930: 25–26). In the book *Tanbīhāt al-munajjimīn*, Junābādī points out that he was witness to the Great Comet of 1577 that appeared in the west towards "… the latter part of Sha'bān [ca. 2–12 November, 1577]." Lastly, he refers to two consecutive comet sightings in the year 1027 A.H. The reference is made at two places in Kennedy, the first of which reads:

> "In the beginning of Dhu al-Ḥijja 1027 H. (ca. 21 November 1618), while the royal court was at Qazwin (northwest of Tehran), a *ḥarbah* appeared in the east, in the sign of Libra". In a later chapter, the author describes – "On the morning of Monday, 8 Dhu al-Ḥijja (26 November 1618) of the (above) mentioned year, a comet (*Au dhawaba*) appeared in the east in the middle of the sign of Scorpio and lasted for about forty days". (Kennedy, 2019).

Normally one says *dhūdhnab*, meaning *dumdār* ('one with a tail'). The Royal Court referred to above is that of Shāh Abbās I. The 1027 AH references in the *Tanbīhāt al-munajjimīn* are correct and made in respect to two different comets, now identified as C/1618 V1 and C/1618 W1 (Kapoor, 2016).

8 PERSIA'S EXPOSURE TO MODERN ASTRONOMY

The period under Shāh Abbās I (i.e. 1588–1629) is said to be the Golden Age of Persian civilisation, when Isfahan—the capital since 1598—flourished and became an international city and a great centre of culture and commerce. Diplomats from European countries and merchants visited to foster trade, while delegates from different religious orders came, intent on founding convents in Isfahan and elsewhere in Persia (Bomati and Nahavandi, 1998). Political stability continued during the regime of Shāh Abbās II, and life was good. Shāh Abbās II also maintained diplomatic contacts with Europe, the Ottomans and the Mughals of India, etc., including the British East India Company, the Dutch East India Company (*Vereenigde Oostindische Compagnie*) and the maritime companies of Europe (Dale, 2010). A significant political occasion in his reign was his military expedition to Kandahar where he wrested it back from the control of the Mughals in 1649 (Matthee, 2014). Kandahar was on a crucial trade-route between the two empires.

Father Cristoforo Borri S.J. (1583–1632) was an Italian Jesuit missionary known for his astronomy and making magnetic observations in Asia that would provide an ingenious way of determining longitude. In April 1615 Borri left Lisbon for Macao, stopping over at Goa for six months, and arriving in Macao in 1617. The mission soon faced unfavourable circumstances and he moved to Cochin-China (the southern region of Vietnam). It is from here that he observed the two bright comets of 1618. Unfortunately for him, Father Borri could not adapt to the local circumstances, so he decided to return to Europe. He went to Macao in 1622, and later that year left for Goa. He stayed in Goa until February 1624, when he eventually set sail for Lisbon, together with Garcia de Silva y Figueroa (Dror and Taylor, 2006: 40–42).[3]

While he was in Goa in 1623, Father Borri befriended a well-to-do and knowledgeable Roman nobleman, Pietro della Valle (1586–1652), who had travelled far and wide and knew many languages. The celebrated traveller described Borri as a great mathematician who shared with him the Tychonic world-view and also his own perception of three heavens. Father Borri had been developing his theory of tenuous heavens and recorded his views and observations in a book. An impressed Pietro translated this work into Persian in 1624, with the title *Risalah- i Padri Khristafarus Burris Isavi dar tufiq-i jadid dunya* (*Compendium of a Tractate of Father Christoforo Borri Giesuita on the New Model of the Universe According to Tycho Brahe and the Other Modern Astronomers*). He even sent it to his Persian astronomer friend Mulla Zayn al-Din of Lār, who was keen to learn about the new European sciences.

Here was one of the first Western works on the 'new astronomy' to reach Persia that

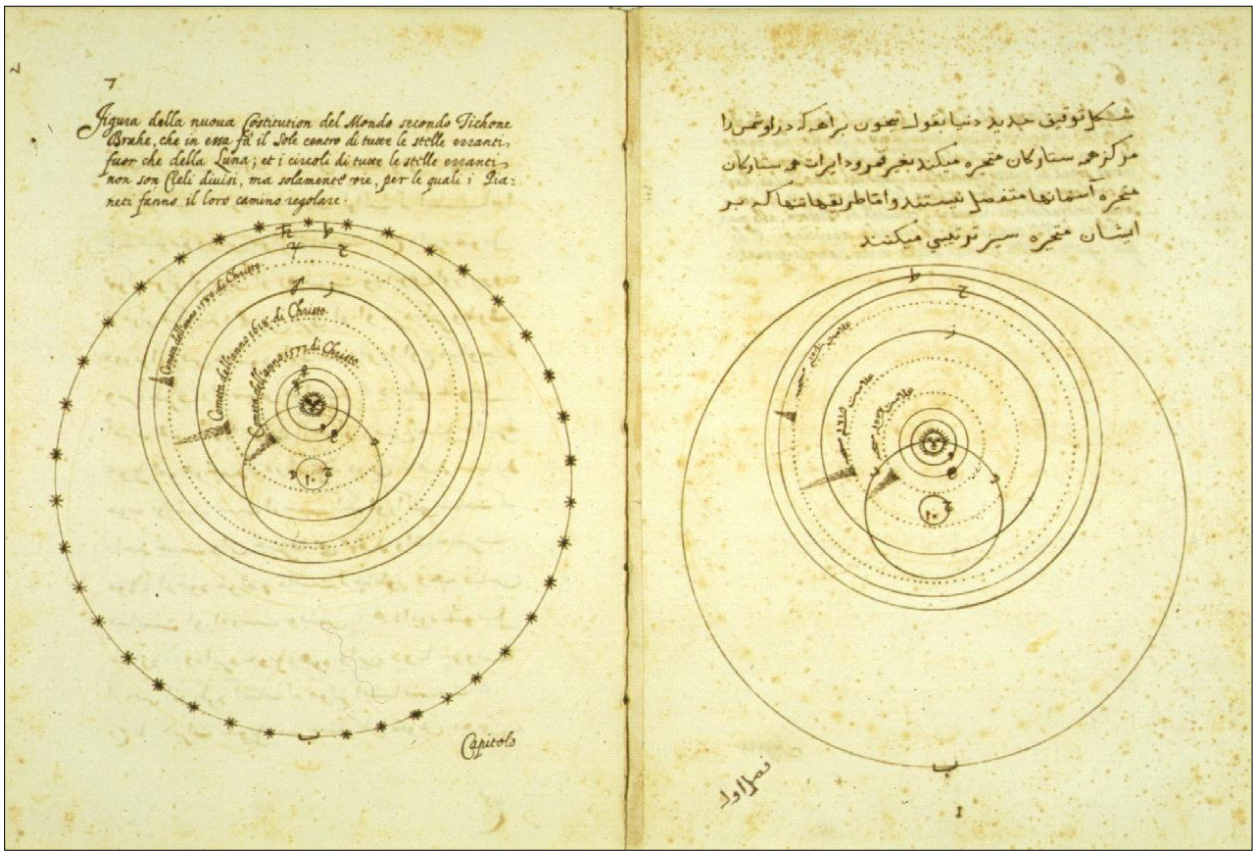

Figure 8: Father Christoforo Borri's model of the Universe based on observations by Tycho Brahe and other astronomers (after della Valle, 1631).

propagated a world-view contradictory of the cosmogony of the East. Later, in 1631, while in Rome, Pietro translated Borri's work into Italian: *Compendio di un Trattato del Padre Christoforo Borro Giesuita della Nuova Costitution del Mondo secondo Tichone Brahe e gli Altri Astologi Moderni.* This book is preserved in the Vatican Apostolic Library (Vat. pers. 10 fols. 7 recto - 6 verso orient18 IGH.06) and carries a depiction of Tycho's hybrid Universe with the planets revolving around the Sun and the Sun round the Earth (Figure 8). A few comets in orbits are depicted too, with tails pointing away from the Sun to demonstrate that comets could not be carried by the crystalline spheres. Importantly, the book was well received by scholars in Persia, Armenia and Arabia.

Of the several comets that appeared after the Great Comets of 1618, the first bright one worth noting was the comet of 1652. This was followed by several others, and bright ones appeared in 1661, 1664, 1665, 1668, and so on. The paintings discussed in this paper could be records of two such apparitions.

In this context, of great significance are the reports, dated 3 April and 23 April, by Father Raphaël du Mans (1613–1696; Richard, 1995) of his observation of the Great Comet of 1668 made from Isfahan that he sent to the French Consul in Aleppo (King, 1999: 139–140). Raphaël du Mans had come to Isfahan in 1647 to head the mission of the French Capuchins, a Roman Catholic order. He also became associated with the Royal Court in order to serve the interests of his country, and he lived in Persia until his death. He knew Persian and was highly regarded by local people as an expert on mathematics, astronomy, optical science and philosophy. He also is said to have constructed astronomical instruments. He would have been in contact with the astronomers at the Shāh's Court. One of them, Muḥammad Zamān ibn Sharaf al-Dīn Ḥusayn of Mashhad, was active during 1643– 1689 (The Metropolitan Museum of Art, 2018), and is known to have built astrolabes and celestial globes and written a *zīj* for the Shāh circa 1668 (Landau, 2009: 196–197). It is also likely that Father Raphaël would have come across the painter Muḥammad Zamān at the Royal Court (Landau, 2009: 196–197).

In his report (written in French) about the Great Comet of 1668, Father Raphaël wrote that it was 30° 32′ in length with a uniform width of 3½°, and red coloured (King, 1999: 139–140). His figures for the comet's length and width suggest how well he was able to use the astronomical instruments in his possession and also reflect his computational skills. Whether

he used a telescope to observe the comet is not known. In this context, it is interesting to note that among other gifts the Royal Court received European optical instruments (ibid.), and that not only had telescopes reached Persia by the 1660s but Father Du Mans himself had constructed the first Galilean telescope in Iran (Arjomand, 1997: 7). It is stated that Father du Mans used it to view the night sky:

> A seventeenth-century Persian scholar by the name of Mirzā ʻAbdullāh Iṣfahānī wrote a book called "The Garden of the Scholars" (*Riyas al-ʻUlamā*') in which he refers to Father du Mans and a telescope that du Mans possessed. The instrument was 2.08 meters long and shaped "like a bamboo pipe, somewhat like the Indian reed from which spears are made." With it, many strange things could be seen. Apparently, Isfahani had the opportunity to view the sky through the telescope. He reported that many stars not seen before were revealed, including a vastly expanded Pleiades (Seven Sisters) that clearly could not be taken in with one view, given the narrow telescopic field of vision. Looking at the moon's rough and uneven surface suggested to viewers in Iran that there were "lands, jungles, and cities on the moon". (Huff, 2010: 132–133).

Pouria Nazemi (pers. comm., 2018) points out that during the 1620s an Italian missionary had brought a telescope to Persia and even organised an observing session for the Shāh and his courtiers. That, however, was a solitary occasion only.

The observations that Father Du Mans reported to the French Consul at Aleppo were the first modern observations of a comet made from Persia where a telescope may have been used. Ironically, there are no accounts of the 1668 comet by Persian scholars or astronomers. Nevertheless, it surely would have had a major political impact on Royalty. Of great interest here is the story of the repeat coronations of the Safāvid ruler Safi Mirzā (1648–1694), first after the death of Shāh Abbās II as Shāh Safi II in October 1666, and later as Shāh Sulaymān in March 1668. The reason given was his continuing ill health caused by over-indulgence, which began getting worse after he ascended the throne. During his reign there was a severe drought, earthquakes, and unrest in the north. So, the Court astrologers, who were always in attendance and ready with their astrolabes and ephemerides for counsel (Chardin, 1711a(II): 117–118; Richard, 1995), resolved that Shāh Safi II had been crowned in inauspicious circumstances and, in order to ward off evil, needed to be crowned again and assume a new name (Matthee, 2015: 67–98). While speaking about Persia's *Estat de 1660*, Father du Mans recalls how the kingdom

> … annually spends more than 20,000 tomans to maintain his astrologers, munajjims, who are all near him with their astrolabe[s] to take the right hour, the ascendant, to divide the sky in 12 parts according to houses, etc., to tell when it is good to sit, to get up, to leave, to eat, to sleep, to vest such or such a colour, so that he is in the absolute disposition. (Richard, 1995: 125).

Father du Mans further notes that

> These astrologers draw their tables, like us, each year from the mean motion of the planets, what they call estekhrage [Arabic for calculation]. For the longitudes and latitudes of the courses of the stars, as well as for the eclipses of our two great luminaries, they have very few differences with ours; they use the system of Ptolemy. They have zījes, which are their tables of average movements, composed by a scientist of the Tartars named Ulugh Beg, calculations established 400 years ago. In the great conjunction of Saturn and Jupiter, they had made a mistake of two months and our [Andrea] Argoli tables had calculated them well.[4] They consider their representations of the courses of the stars from an old author by the name of Abd al-Raḥmān [al-Sūfī] but they are mistaken in the longitudes of fixed stars by eight degrees, and from this index it can be concluded that these tables and that the author of these tables are many years older than our modern ones. (Richard, 1995: 359–561).

The second ascension of Shāh Safi II took place on the *Nauroz.* Notably, it was the day of the Vernal Equinox when the Sun moved into Aries and marked the first day of the first month *Farvardīn* in the Persian calendar, a day for the commencement of festivities. In 1668, the vernal equinox fell on 20 March. This date tallies with when the comet was still in its dramatic phase. We believe that it was the continuing presence of this formidable sign in the sky, that had appeared in the month of *Ramaḍān* (14 February–14 March), which prompted the astrologers—fearing even greater disaster ahead—to moot the idea of re-crowning the King and changing his name. And what other day could be more auspicious than the *Nauroz* that lay just a few days ahead.

The comet of 1668 has figured in the memoirs of a few European visitors. Chardin (1643–1713), the merchant-traveller and son of a Huguenot jeweller who had come to Isfahan in the beginning of 1666 through orders that his father received from Shāh Abbās II for jewellery, mentioned observations of the comet in his *Voyages en Perse II* (Chardin, 1711a: II: Chapter IX). He travelled around Asia and returned to spend five years in Isfahan, first six months in 1669, and then four and a half years from June 1673 (King, 1999: 139–140). His

writings on Safāvid Persia are spread over ten volumes wherein he also elaborates on how the science of astronomy was revered and cultivated in Persia:

> They quite rightly observe the revolutions of the Eclipses of Sun & Moon, and often meet the moment of the obscurity of these two Luminaries; but sometimes they mistake half an hour, especially in the Eclipse of the Sun; but it must be said also that in the supposition that they make of it, they do not disarm the brain, as do the European astronomers, in the calculation of so many small parallactic Arcs of longitude & latitude ... They have no Telescopes to observe either the Constellations or the Phenomena of Heaven; as it is said that the ancients had none, and all the astronomers before Tycho Brahe: I say this generally speaking; for it is necessary to except some curious Mathematicians, who since the Europeans came to Persia, of whom they have seen Celestial Globes, have started to make small ones, as I have seen … (Chardin, 1711a(II): 119).

Chardin (ibid.) recounts the interest shown by the elite class in new inventions from Europe. He also observed that the Persians were not accustomed to comets:

> They believe that these phenomena always presage great misfortunes, but they are ingenious in returning their influence to distant countries. They do not give a common name to this sort of Meteora, as we flee by calling them all comets; but they give them the name according to the figure they represent ... They named the great and famous comet, a little spear that appeared almost all over the world in the year 1668. Here is her face, as she was drawn up in the Province of Persia; but I shall not point the relation of it, having given in the Message of Soliman; to which I will only add, that the colour of this Comet was red, mingled with black and yellow …

Chardin (1711a(II): 118) even presented a geometrical illustration of how the comet was placed in the sky on the second day of the apparition, which was 7 March, viewed from Shiraz, the capital of Fars Province, and this is reproduced here in Figure 9.

It is a coincidence that in 1085 AH when ʾAlī Qulī Jubbahdār did his painting *Two Old Men in Discussion Outside a Hut* and there was no comet in the sky, Chardin was in Isfahan from 2 July 1674 until 18 May 1675 (Chardin, 1711b: III). The Gregorian dates of the Hijri year 1085, namely 7 April 1674–27 March 1675, are therefore suggestive in the present context. Chardin moved in socio-political circles and on occasions would have discussed his own impressions of unforgettable experiences, but we do not know if he and Jubbahdār ever met. Nevertheless, there would have been enough anecdotes available to provide the input Jubbahdār needed to present the *Two Old Men* talking about an extraordinary object in the sky.

After the fall of the Safāvids, Persia's interaction with the West remained at a low level until the arrival of the Qājārs in 1786. The interest in new knowledge slowly began to grow, but the resistance of the traditional scholars towards modern scientific thought continued until the middle of the nineteenth century. Pouria Nazemi (pers. comm., 2018) traces Iran's modern beginnings in astronomy to Mirza Mahmoud Ghomi (Qomi), alias Moshaver al-Molk Mahmoudi (cf. González, 2018: Chapter 2). Ghomi was one among the forty-two students sent to Europe in 1858 on State scholarships to learn modern science and technology and bring knowledge back to Persia for the benefit of the country:

> The first telescopes which were brought into Iran for the astronomical and observational purpose were during Naser al-Din Shah Qajar (1848–1869). We know that it was imported into Iran by Mahmoud Ghomi an Iranian scientist and astronomer who studied astronomy in Paris and for a short time worked at the observatory of Paris and Belgium. He was also the first person who requested the king to found the project of 'Persian Royal Observatory' which was denied. He held many observing events at the top of Shams-el-Emare in Tehran for the King and his family. The first professional and scientific optical observatory in Iran was the solar observatory of the geophysical research centre of the Tehran University which was built in 1963. (Pouria Nazemi, pers. comm., 2018).

9 DISCUSSION

The tailed celestial forms in the Persian paintings under discussion could either be drawn from the imagination of the artists or from astronomical records. From the inscribed dates, and if they indeed depicted comets, the objects were identified as the comets of December 1664 and 1674–1675 respectively (Landau, 2011; The Metropolitan Museum of Art, 2018). Curiously, there were no comets in the sky around the inferred dates. Bearing in mind the mysticism and concern that revolved around comets, the depictions in the paintings may have been inspired by real apparitions that were simply unforgettable. Both the artists chose late evening settings for their illustrations. They would not make such a mistake as to witness a comet in the morning but present it as an evening event. This has led us to zero in on the bright comet of 1652 in the case of Zamān's painting and the Great Comet of 1668 in Jubbahdār's painting. If so, the depictions were done from memory only.

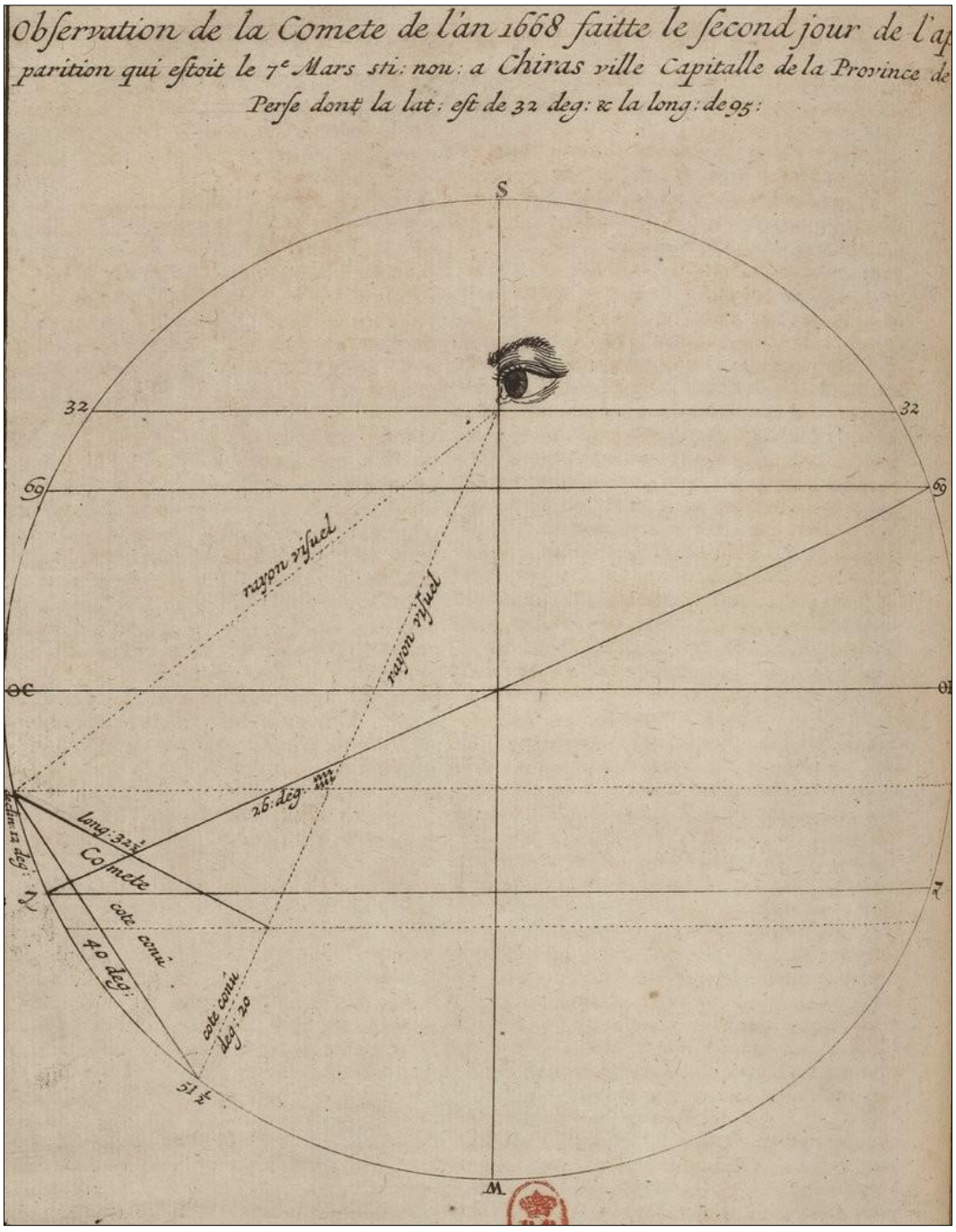

Figure 9: A page in Chardin (1711a(II): 118) with a geometrical illustration of the observation of the comet of 1668; "Source gallica.bnf.fr / BnF" (https://gallica.bnf.fr/ark:/ 12148/bpt6k1050392t/f144.item.zoom accessed 05 August 2019).

But equally, the paintings may have been inspired by observations of two outstanding fireballs that were personally witnessed by the artists. In Jubbahdār's painting, if it was a fireball then the date (i.e., 1085 AH) is no issue, but this is not so of Zamān's painting.

Notably, around the dates inscribed, there were no political upheavals in Persia big enough to be connected to any apparitions as signs of calamity. There were no eclipses either. The near total solar eclipse of 12 August 1654 with a magnitude 0.999 over Isfahan that lay on the western edge of the path of totality, or the total lunar eclipse of 17 July 1674, should have been sensational enough and the related anecdotes vivid in the memories of the people. It is as well that the eclipses would have been predicted. Similarly, neither the death of Shāh Abbās II in 1666 nor the re-crowning of Safi Mirzā in 1668 as Shāh Sulaymān could inspire the painters. That makes the subject of the paintings even more exceptional.

A crucial character, namely, the princely figure that Zamān chooses for his story looks more an Indian than a Persian in appearance. Recall that Isfahan was home to some 10,000

–20,000 Hindus at the time, a major fraction being the merchant-class (*les baniyān*) as observed in their memoirs by several European travellers (e.g. Richard, 1995: 149). Traditionally, Hindus are afraid of eclipses, not comets, and for the former, the Prince would have no dearth of expertise. Zamān seems to transpose the irrational fears common to his culture to a Hindu to show his concern about the repercussions of the appearance of an imposing form in the sky. It could be the artist's attempt to affirm Islamic knowledge of comets over Hindu perceptions of the same. That waters down the supposition that the painting may have been done in India.

Interestingly, the settings in the two paintings resemble that in a miniature by Govardhan titled 'Astrologer and Holy Men' which is a part of Shāh Jahān's Album (BnF, 1986);[5] and this is shown here in Figure 10. We can only speculate if such paintings influenced Persian artwork since works and copies of the works of the Imperial ateliers would travel between the Mughal and the Safāvid Empires; we know that some of the Mughal artworks even reached the Dutch painter Rembrandt (1606–1669). One may look up another painting, *A Prince Visiting a Hermitage*, which was done by Govardhan circa 1635–1640 (see Beach, 1978: 28 and 73) and has a setting, once again, like the one we see in Zamān's painting.

There are several Mughal period paintings that show astrologers or astronomers at work, with astrolabes and other scientific instruments, books and charts, often at the times of Royal births (Sarma, 2008: Chapter 4). But significantly, there are no paintings in the Mughal memoirs or chronicles that feature astronomical events (see Kapoor, 2016).[6] That was the same in the Middle East from the Medieval Period to the Early Modern Period, barring such exceptions as the miniature in a 1580 manuscript of the *Shāhinshāhnāmā* depicting an astronomer in Istanbul observing the Great Comet of 1577 with a wooden quadrant (vide the *Nuṣretnāme* (1584), from the Topkapi Palace Museum Library: TSMK. H. 1365, fol.5 v (b)). The *Shāhinshāhnāmā* is in Persian verse. It was composed by ʾAlā al-Din al-Manṣūr, and it chronicles the early phase of the reign of the Ottoman Sultan Murād III (r. 1574–1595). Here, in a verse, it refers to the appearance of the comet (Ben-Zaken, 2010: 12).

10 CONCLUDING REMARKS

In this paper I have tried to investigate two Safāvid period paintings, by Muḥammad Zamān and ʾAlī Qulīʾ Jubbahdār respectively, that depict comets or fireballs. Both paintings show celestial objects with tails and are most likely astronomical records. I find that the bright comet of CE 1652 and the Great Comet of CE 1668 respectively are the best fits. But as we have already noted, there are serious problems with these attributions, so that the objects in question may in fact be fireballs.

Notably, the artists, in an obvious departure from religious and political thought, invoked celestial tailed forms to weave specific themes on their canvases. Although the two paintings were done independently, their situations are similar. There is emphasis on erudition, which is a tribute to the system of knowledge in Persia at that time. The artists 'touch two ends of a thread': Muḥammad Zamān weaves a story around a celestial visitor with an evil dimension, while ʾAlī Qulīʾ Jubbahdār's work is esoteric, and focuses on the nature of the tailed object. The artists are to be congratulated for forging an aesthetic connection between astronomical knowledge and art. The depictions evince the whiff of fresh air blowing into Persia after it opened its doors to the West, but was not yet very receptive to the new knowledge. Nevertheless, it touched a relevant section of the society, the aristocrats, the scholars and some others. Many were exposed for the first time to the telescope and the wonders of the

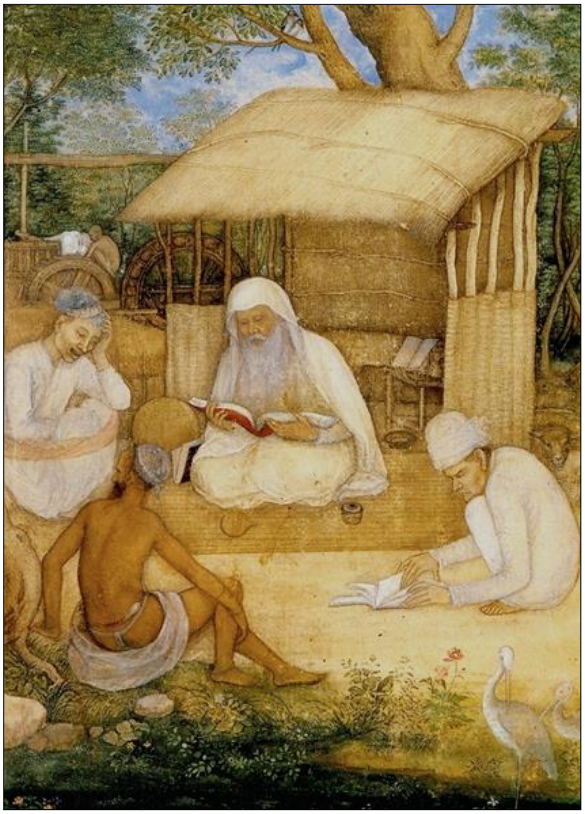

Figure 10: *Astrologer and Holy Men*, by Govardhan. A page from the Late Shah Jahan's Album, Musée Guimet, Paris, MA 2471. 'Gouache on paper, Mughal School, circa 1630. The old man draped in white, seated under a straw awning and absorbed in his reading, is no doubt an astrologer, as indicated by the books and instruments scattered at his side: a globe, a pendulum, an inkpot and on the floor of the hut, an hourglass' (BnF, 1986) (Source: Wikimedia Commons).

night sky through immigrants, like the astronomer Father Raphaël du Mans from the mission of the French Capuchins in Isfahan, and through European travellers and merchants. Ironically, this happened at a time when the Safāvid Kingdom was beginning to decline.

Finally, I certainly cannot close this paper without addressing the ultimate question: "What do I think Muḥammad Zamān and ʾAlī Qulī' Jubbahdār intended to depict in their paintings?" Professor Razaullah Ansari (pers., comm., June 2019) reminds us that

> … whereas the appearance of a fireball is a transient one-night phenomenon, comets appear after several years for several days in the morning and again in the evening sky. The former cannot be something worth depicting by an artist, whereas comets with their astrological influences and long tails could undoubtedly trigger an artist's imagination.

While artists certainly have included comets in their paintings (e.g. see Olson, 1985; Olson and Pasachoff, 1998), and famous events like the Leonid Meteor Storms have also attracted ample attention, it is clear that some artists did in fact intentionally depict fireballs or bolides in their work—as discussed by Olson and Pasachoff (1998) in their classic work and in their outstanding new book, *Cosmos: The Art and Science of the Universe* (2019). Nevertheless, I feel that Muḥammad Zamān and ʾAlī Qulī' Jubbahdār meant to show comets in their paintings, unforgettable naked eye objects that they had viewed some years previously which so impressed that they left indelible images in their memories. What better way of rescuing these images for posterity than to paint them!

11 NOTES

1. Tenebrism (n.d.) is "… a style of painting … where there are violent contrasts of light and dark, and where darkness becomes a dominating feature of the image. The technique was developed to add drama to an image through a spotlight effect …"
2. Manucci (1907: 17–18) mentions meeting an 'intelligent' Persian by the name of Muḥammad Paulo Zamān at Emperor Aurangzeb's court. Zamān had been sent by Shāh Abbās II to Rome to study the Christian faith. He returned greatly influenced, and had to flee Persia fearing persecution by the Shāh over his conversion. He sought asylum in the Mughal Empire and was sent to Kashmir. However, according to Landau (2009: Chapter 2), this person is not to be confused with the painter Zamān.
3. Comet 1618 II (C/1618 W1; Great Comet) probably was first seen on 23 or 24 November by Garcia de Silva y Figueroa (1550–1624) from Isfahan. It was in the east, a diffuse object, and had the colour of Venus (Kronk, 1999: 338–341). Garcia de Silva was the Ambassador of Philip III (the King of Spain and Portugal) to the court of Shāh Abbās I (r. 1588–1629). He had travelled extensively through the country including to the city of Shiraz and the ruins of Persepolis. The third bright comet of 1618, Comet 1618 III (C/1618 V1) was spotted earlier than the comet 1618 II, on 11 November, by Garcia de Silva y Figueroa from Isfahan. It was visible in the south-east and had a tail about 60° long (Kronk, 1999: 335–338).
4. Jupiter and Saturn came within ~1° of each other on 18 October 1663, in the constellation of Sagittarius. As for 'Argoli', the reference might be to a recent edition of his *Ephemerides*.
5. Shāh Jahān's Album was actually initiated by Jahāngīr (r. 1605–1627), the fourth Mughal Emperor of India who then passed it on to his son Shāh Jahān (r. 1628–1658). The latter arranged for several paintings, illuminations and calligraphy folios to be added to the Album (Viswanathan, 2010).
6. Jahāngīr recorded in his *Tūzūk-i Jahāngīrī* (*Memoirs of Jahāngīr*) the appearance of two bright comets during a Royal excursion from the town of Dohad in Gujarat to Agra, the capital city of the Empire, via Ujjain, in the thirteenth year of his accession, i.e., 1027/1618. From the recorded dates, we have identified him as the independent discoverer of these two Great Comets, C/1618 V1 and C/1618 W1; the first was sighted on 10 November 1618 and the other sixteen days later (Kapoor, 2016). Jahāngīr's astronomers used an astrolabe to measure the length of the tail of the first comet as 24°. The comets created a sensation in Europe, and in India would have been the subject of talk within the Royal entourage and back home for quite some time. However, there is no artwork showing Jahāngīr observing either comet, even though his atelier included many skilled artists. In this context, one may refer to Bichitr's 'Jahangir Preferring a Sufi Shaikh to Kings' or Abū'l Hasan's 'Jahangir Embraces Shāh Abbās While Standing on a Globe'. Abū'l Hasan had painted some of the best-known illustrations of the Emperor in the year 1618. Many of these paintings are presented and discussed by Beach (1978: 28 and 73) and by Bailey (2001: 47–59).

12 ACKNOWLEDGEMENTS

My sincere thanks are due to the referees for

their insightful remarks and useful suggestions. I also thank Professor S.M. Razaullah Ansari (Aligarh Muslim University, India), Professor Mohammad Bagheri (Center for Kushyar Studies, University of Guilan, Iran), Dr S. Mohammad Mozaffari (Research Institute of Astronomy and Astrophysics of Maragha, Iran) and Mr Pouria Nazemi (science journalist, Montreal, Canada) for useful correspondence and helpful comments. Mr Manu Kapoor provided crucial help at the computer. I acknowledge the support of the Director, Indian Institute of Astrophysics (IIA), and thank the Library staff at the IIA for help with accessing various references. The figures in this paper were gratefully adopted from the collections of The Metropolitan Museum of Art, New York (https://www.metmuseum.org/), Bibliothèque Nationale de France, Paris (https://www.bnf.fr/fr) and Wikimedia Commons. Certain passages from original French sources that I have quoted are software-assisted translations. This research has gratefully made use of NASA's Astrophysics Data System, the "On-Line Solar System Data Service" of the Jet Propulsion Laboratory, "Eclipse Predictions by Fred Espenak, NASA/GSFC Emeritus", and classical reference material available on the internet. Finally, I am grateful to Professor Wayne Orchiston for help in finalising this paper.

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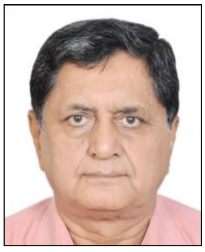

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