The First Astronomical Use of the Telescope in India

R. C. Kapoor

Abstract For astronomical observations, a telescopic device was used in India, within a decade of its invention. The year was 1618 but what astronomical objects were observed? That is connected with the tale of two great comets of November 1618.

1 The Bright Comets of 1618

The year 1618 was a unique one in that it presented three Great Comets within a short span of 3 months. It also saw the novel use of the telescope for observations of all three Great Comets. In order of occurrence, the comets were:

- 1618 I (C/1618 Q1; perihelion August 17.627 UT),
- 1618 III (C/1618 V1; October 27.9) and
- 1618 II (C/1618 W1; November 8.851).

All the comets were naked eye objects, with long tails and motion direct, and they were noticed after their perihelion passages. The last two comets were sighted in November, within a short span of time, in the same region of the sky, and they were visible together for several successive days.

These comets belong to the era when Galileo‘s telescopic observations had just created a paradigm shift in our perception of the heavens and Johannes Kepler was busy introducing a fundamental change in mathematical astronomy by redefining the orbits of planets around the Sun. With three sightings in quick succession, these comets were a sensation in European astronomical circles. They even drew Galileo Galilei (1564–1642) into a controversy with the Jesuit mathematician Father Horatio Grassi (1583–1654) over the nature of comets. Grassi stressed that these apparitions were against the Copernican worldview. These comets also generated grave concern among the general population, and left an indelible imprint on many minds.

R. C. Kapoor (✉)
Formerly at Indian Institute of Astrophysics, Koramangala, Bengaluru, India
e-mail: rck@iiap.res.in

W. Orchiston et al. (eds.), *The Growth and Development of Astronomy and Astrophysics in India and the Asia-Pacific Region*, Astrophysics and Space Science Proceedings 54, https://doi.org/10.1007/978-981-13-3645-4_4

Comet 1618 I (C/1618 Q1) was discovered at Caschau in Hungary on 25 August in the morning skies at magnitude 2–3, and then independently by Johannes Kepler (1571–1630) at Linz on 27 August. This holds the distinction of being the first comet ever to be observed with a telescope—by Kepler—on 6 September.

Comet 1618 II (C/1618 W1) was probably first seen on 23 or 24 November by Garcia de Silva y Figueroa (1550–1624) from Isfahan in Persia, toward the east as a diffuse form and having the same colour as Venus. Garcia de Silva was the Ambassador of Philip III, the King of Spain and Portugal, to the court of the renowned ruler Shāh Abbās (1571–1629).

There is some confusion about the date when this comet was first sighted. Actually, the earliest to record it were the Chinese who found the comet in Libra on 25.9 November (Kronk, 1999: 338–341). Father Johann Cysatus (1587–1657), then at Ingolstadt, was the first to use a telescope and detect structure in a comet's head—a nucleus, a nebulous envelope (coma) around the nucleus, and a relatively fainter appearance—the halo—around that. He noted that the comet followed a path that began to deviate from a stipulated straight line, commenting that "This curvature (of the orbit) would be a phenomenon of great importance, if it could be confirmed by more observations." (Schreiber, 1904:100).

Comet 1618 III (C/1618 V1) was spotted earlier than 1618 II, on 11.04 November, by Garcia de Silva y Figueroa from Isfahan in Iran. It was in the south-eastern sky and had a tail ~60° long.

For detailed account of these three comets, see Kronk (1999), Vsekhsvyatskii (1964) and Williams (1871).

2 The Comets of November 1618

The last two Great Comets of 1618 were observed from India too.

The Emperor Jahāngīr (1569–1627, Fig. 1) recorded these comets appearing in succession during a Royal journey from Dohad (Dahod) in Gujarat to Agra, the capital of the Mughal Empire, via Ujjain, in the year 1027 A.H. (1618 CE).

At around the same time, these comets were observed by a number of Jesuit missionary-astronomers what at that time were based in India. Father Wenceslaus Kirwitzer (1588–1626) observed the Comet 1618 III from Goa, and was joined by brother Jesuits in Goa and in Cochin. In quick succession they then observed the second Great Comet of November 1618.

The observations of two of the three Great Comets of 1618 from India in November turned into a unique occasion when the same targets of opportunity were followed independently by astronomers from two very different cultures, and their observations were recorded quantitatively.

Fig. 1 Nūr ud-Dīn Jahāngīr (1569–1627) (Wikimedia Commons)

3 Jahāngīr, The Naturalist

Jahāngīr, the fourth Mughal Emperor of India (r. 1605–1627) was a great naturalist and a gifted author. Apart from ornithology, biology and lexicography, he had an interest in astronomy and maintained records of his observations in his journal *Tūzūk-i Jahāngīrī*. In the other Memoir he wrote, the *Wāki'āt-i Jahāngīrī*, we find very similar descriptions. In these Memoirs, we find descriptions of a few natural phenomena that he observed. In the *Tūzūk-i Jahangīrī* he writes about the fall of a meteorite in a village in the Jalandhar district in Punjab in his 16th regnal year (i.e., 19 April 1621 Greg); a few solar and lunar eclipses; and two bright comets that he observed. Jahāngīr's Memoirs clearly demonstrate his interest in astronomy and the level of accuracy he reached with his observations. We find the recorded information in excellent agreement with modern computations. For their observations, Jahāngīr's astronomers used astrolabes, accurate water-driven clocks (clepsydras), sundials and sandglasses (e.g. see Fig. 2).

Fig. 2 An astrologer and his equipment; margin drawing from the folio of Jahāngīr's Album depicting an astrologer surrounded by his equipment—an astrolabe, zodiac tables and an hour glass. (Courtesy: Werner Forman Archive/ Naprestek Museum, Prague)

3.1 Jahāngīr's Observations of the Comets

The following passage from Jahāngīr's Memoirs, *Tūzūk-i Jahāngīrī*, pertains to the account of the 13th year of his reign, i.e., 1027 A.H. (Rogers and Beveridge 1909, 1914):

> On Saturday the 18th (Aban), the camp was at Ramgarh. For some nights before this there appeared, at three gharis before sunrise, in the atmosphere, a luminous vapour in the shape of a pillar. At each succeeding night it rose a ghari earlier. When it assumed its full form, it took the shape of a spear, thin at two ends, and thick in the middle. It was curved like a sickle, and had its back to the south, and its face to the north. It now showed itself a watch (pahar) before sunrise. Astronomers took its shape and size by the astrolabe, and ascertained that with differences of appearance it extended over twenty-four degrees. It moved in high heaven, for it was first in Scorpio and afterwards in Libra. Its declination (harakat-i-arz) was mainly southerly.
>
> Sixteen nights after this phenomenon, a star showed itself in the same quarter. Its head was luminous and its tail was two or three yards long, but the tail was not luminous. It has now appeared for eight nights; when it disappears, the fact will be noticed, as well as the results of it.

The Persian and A.H. dates in the Memoirs help us follow the course of the Royal traverse from Ahmedabad to Agra, through Dohad and Ujjain. Some of the halts between Dohad and Ujjain, including Ramgarh where the first observation of the comet was made, are no longer readily identifiable.

We have looked into the District Census Handbooks of the Census of India 2011 released in 2015 by the Registrar General & Census Commissioner, India, of the districts of Dohad in the state of Gujarat and Jhabua, Dhar and Ujjain in western Madhya Pradesh. It was through these districts, spread roughly along a west-east corridor, which the Royal entourage would have passed. In the respective census listings there is a Ramgarh near Thandla (*Registrar General* . . ., 2015: 138; see Fig. 3).

In the Memoirs, the celestial positions of the comets are given zodiac-wise only, but the comet's ephemerides generated from its orbital elements can help us fix the dates of the first sightings. In the *Tūzuk-i-Jahangīri*, the first date of observation is

Fig. 3 An outline map of western part of India showing the approximate route of the royal entourage in relation to a few modern locations in the states of Gujarat and Madhya Pradesh that may have lain on or near the stipulated route (map: Ramesh Kapoor)

Saturday, 21 Dhu-al-Qa'dah 1027 A.H. (the 18th of Ābān, 997, Saturday). The morning of this date corresponds to the morning of Saturday November 10, 1618 (Greg).

Jahāngīr's records bear testimony to him having a robust regime, equipped and with ability to carry out accurate astronomical observations. Some idea of the observational precision that Jahāngīr's astronomers could reach can be formed from just one instance. In the matter of the solar eclipse of 29 March 1615 that he observed from Agra, Jahāngīr wrote down the maximum eclipse magnitude attained as four out of five parts of the Sun (0.8) and that the eclipse lasted 8 gharis (3 h 12 min), both very close to the values derivable today. Sheikh Alāhādād's family in Lahore that flourished during the period 1570–1660 CE was highly acclaimed for producing high-precision astrolabes and other scientific equipment.

From Jahāngīr's records, it is clear that Comet 1618 III was first sighted on 10 November, around 00 UT and Comet 1618 II on the morning of 26 November, both post-perihelion. These dates make Jahāngīr an independent discoverer of both Great Comets.

3.2 The Comet Tales from Goa

In its astronomical column, the journal *Nature* (1878) carried in the 24 January 1878 issue a contribution by an unnamed author that stated that the Jesuit astronomer Giovanni Riccioli (1598–1671) had mentioned observations of the comets of 1618 made by a Jesuit astronomer named Kirwitzer from Goa in India. It may be noted that the Jesuits were in Goa from 1542, in order to spread the faith.

'Kirwitzer' was Father Wenzel Pantaleon Kirwitzer (ca. 1588–1626), a member of the Collegium Romanum belonging to the 'Society of Jesus'. Recall that many of the Jesuits of that era were mathematicians, geographers and astronomers, and they carried with them new developments in European science when they went on their missions to different parts of the world. As part of the group of missionaries led by Nicolas Trigault (1577–1628) destined for China that included Giacomo Rho


35. V. 44.

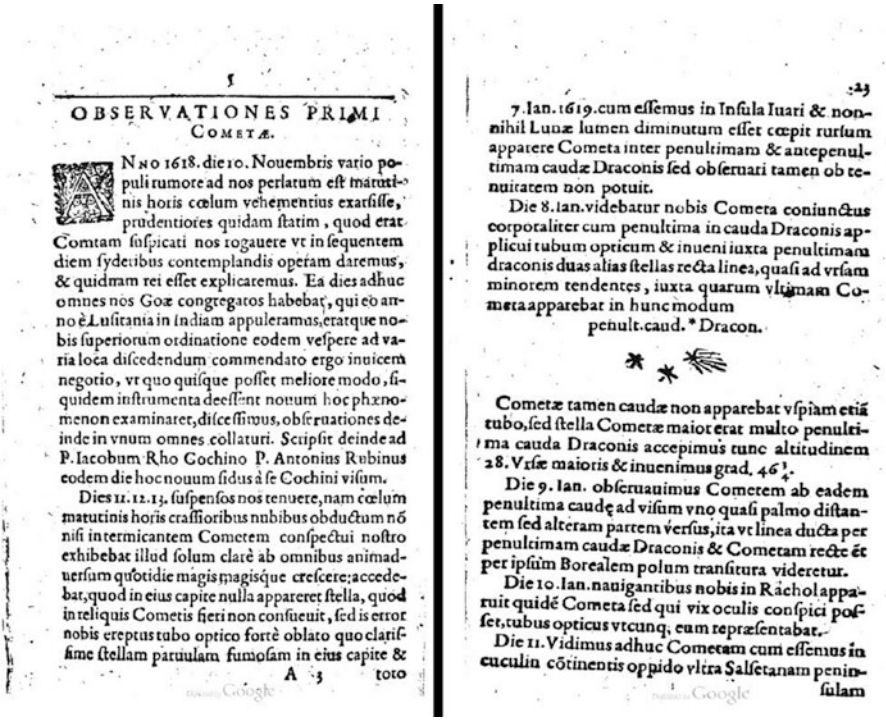
OBSERVATIONES
COMETARVM
ANNI 1616.
IN INDIA ORIENTALI FACTÆ A
Societatis Iesv Mathematicis in Sinense Regnum
nauigantibus ex itinere eo delatis.
Ad eiusdem Societatis Mathematicos & alios amicos
Europæos transmissæ.
PER P. WENCESLAVM PANTA-
leonem Kirwitzer, eiusdem nauigatio-
nis Comitem.
VRSELLIS
Excudebat IOAN. THEOBALD. SCHÖN-
VVETTER.
ANNO 1620.
HOFBIBLIOTHEK · KAISERLICHE · WIEN
Digitized by Google

Fig. 4 The cover page of Fr. Kirwitzer's treatise; digitized in 2014 by The Austrian National Library (after Google Books)

(1592–1638), Johannes Schreck-Terrentius (also Terrenz; 1576–1630) and Adam Schall von Bell (1592–1666), Father Kirwitzer set sail from Lisbon in April 1618 and braving the rigours of the voyage, sickness and the death of 5 of the 22 China missionaries, sailed into Goa on 4 October 1618. The group was carrying a few telescopes, some measuring instruments, and a large number of books.[1]

While he was in Goa waiting for the opportunity to proceed to China Father Kirwitzer took advantage of the unfamiliar skies over India to carry out some astronomical observations. Fortuitously, during his sojourn two Great Comets were visible in the morning skies in November 1618, one after the other, and Father Kirwitzer presented a detailed description of his observations of these spectacular objects in Latin in a monograph titled *Observationes Cometarvm Anni 1618. In India Orientali Factæ A Societatis Iesv Mathematicis in Sinense Regnum Nauigantibus ex itinere eo delatis*. Subsequently, it was published in Ursellis by Schönwetter in 1620 (see Fig. 4).

[1] Along with Terrenz and Adam Schall, Kirwitzer would subsequently proceed to China, leaving Goa on 15 May 1619 and reaching Macao on 22 July 1619. In 1621, Terrenz presented the Emperor with a telescope as a gift.



5

OBSERVATIONES PRIMI COMETÆ.

ANNO 1618. die 10. Nouembris vario populi rumore ad nos perlatum est matutinis horis cœlum vehementius exarsisse, prudentiores quidam statim, quod erat Comtam suspicati nos rogauere vt in sequentem diem syderibus contemplandis operam daremus, & quidnam rei esset explicaremus. Ea dies adhuc omnes nos Goæ congregatos habebat, qui eo anno è Lusitania in Indiam appuleramus, eratque nobis superiorum ordinatione eodem vespere ad varia loca discedendum commendato ergo inuicem negotio, vt quo quisque posset meliore modo, siquidem instrumenta deessent nouum hoc phænomenon examinaret, discessimus, obseruationes deinde in vnum omnes collaturi. Scripsit deinde ad P. Iacobum Rho Cochino P. Antonius Rubinus eodem die hoc nouum sidus à se Cochini visum.

Dies 11. 12. 13. suspensos nos tenuere, nam cœlum matutinis horis crassioribus nubibus obductum nõ nisi intermicantem Cometem conspectui nostro exhibebat illud solum clarè ab omnibus animaduersum quotidie magis magisque crescere; accedebat, quod in eius capite nulla appareret stella, quod in reliquis Cometis fieri non consueuit, sed is errot nobis ereptus tubo optico fortè oblato quo clarissime stellam paruulam fumosam in eius capite &

23

7. Ian. 1619. cum essemus in Insula Iuari & nonnihil Lunæ lumen diminutum esset cœpit rursum apparere Cometa inter penultimam & antepenultimam caudæ Draconis sed obseruari tamen ob tenuitatem non potuit.

Die 8. Ian. videbatur nobis Cometa coniunctus corporaliter cum penultima in cauda Draconis applicui tubum opticum & inueni iuxta penultimam draconis duas alias stellas recta linea, quasi ad vrsam minorem tendentes, iuxta quarum vltimam Cometa apparebat in hunc modum

penult. caud. * Dracon.

Cometæ tamen caudæ non apparebat vspiam etiã tubo, sed stella Cometæ maior erat multo penultima cauda Draconis accepimus tunc altitudinem 28. Vrsæ maioris & inuenimus grad. 46 ¾.

Die 9. Ian. obseruauimus Cometem ab eadem penultima caudę ad visum vno quasi palmo distantem sed alteram partem versus, ita vt linea ducta per penultimam caudæ Draconis & Cometam recte ęt per ipsum Borealem polum transitura videretur.

Die 10. Ian. nauigantibus nobis in Racholapparuit quidē Cometa sed qui vix oculis conspici posset, tubus opticus vtcunq, eum repræsentabat.

Die 11. Vidimus adhuc Cometam cum essemus in cuculin cõtinentis oppido vltra Salsetanam peninsulam

Fig. 5 The pages 5 and 23 from Father Kirwitzer's book of 1620 on his observations of the two Great Comets that appeared in November 1618. Both the pages mention the use of a telescope for viewing the comets (after Google Books)

3.3 Father Kirwitzer's Treatise

The treatise is short, consisting of 24 pages only and signed ex 'Goæ in India Orientali 11. Febr. 1619' (Kirwitzer, 1620). In the Preface he refers to being dispatched to India by Muzio Vitelleschi (1563–1645), the Sixth General of the Society of Jesus, to bring the light of the Gospel in the great Empire of the Chinese. The significance of Father Kirwitzer's treatise lies in the fact that it reports the first-ever modern astronomical observations carried out in India. Also, it records the first-ever use in India of an optical device for astronomical observations soon after the introduction of the astronomical telescope in Europe (Fig. 5).

3.4 The Tubo Optico *Reference*

His first recorded use of the telescope in India dates to 10 November when Father Kirwitzer said that many people from the locality approached to tell him of and seek explanation for a vehement flaring up in the morning sky. Father Kirwitzer suspected

that it was a comet and told them he would explain the next day after watching it. He felt that to be examined, the new phenomenon needed instruments and joint efforts. The same day he wrote to Father Jacobus Rho, and to Father Antonius Rubinus at Cochin, 660 km south of Goa, about the new star that had been seen. However, their baggage was still on board the ship, so they had no access to astronomical instruments or books.

In his treatise, Father Kirwitzer refers to a few places where the Jesuits had made astronomical observations. One was Rachol, a town south of Panjim (now Panaji) and home to the Patriarchal Seminary of Rachol, since 1610, which was built by the Jesuits atop a small hillock and evolved into a multipurpose institution. Father Kirwitzer wrote that he sometimes observed from 'Insula Ivari' and sometimes from 'S. Paul'. The Insula Ivari must be the Island of Divar in North Goa, 10 km north of Panjim. The Mandovi River is forked around the island, and the Jesuits used canoes to reach the island. S. Paul would be the famous New College of St. Paul, east of Panjim. It was initially known as the Convent of St. Roch, but in 1610 it changed into a college and was given the name New College of St. Paul.

Father Kirwitzer records in detail what the observers saw and measured, namely, the altitudes and azimuths, angular distance from stars like Spica etc. in grad (degrees), and the observers' visual impressions, including difficulty from illumination due to the Moon and sunlight. The only astronomical instruments the Jesuits were able to access while they were in transit were the sole *astrolabium* (astrolabe) and *radium astronomicum* (astronomical radius, i.e., cross-staff) belonging to Goa College. A cross-staff consists of a staff with a smaller, sliding transversal arm, generally made of wood but sometimes of brass and bearing a scale that could read in degrees directly. Notably, the measurements given by Father Kirwitzer were in arc minutes, to a fraction of a degree.

3.4.1 The First Comet

As Father Kirwitzer writes, dark clouds in the morning hours held them in suspense of any observations through 11, 12 and 13 November, but providence intermittently showed that the comet was growing day-by-day. Father Kirwitzer looked for a star in the head, as is typical of the comets, but found none. However, when he fetched a *tubo optico* (Fig. 5) it clearly revealed a star with a little nebulous head that appeared pale in colour. The comet's figure could not be better explained than palm leaves, and it stretched as a straight smoky column from the east to the midst of heaven, with the tip a little turned to the north.

3.4.2 The Second Comet

> On 24 November, before the sunrise, in the dawn, this comet appeared that we saw in the Insula Ivari. Its star was clear even in comparison of Venus, with short tail and a straight line with Arcturus and Mars also passed to the Comet star, so that the distance between Arcturus and Mars was three times that between the star of the Comet and Mars.

From 28 November, two sets of observations for each comet were being taken from a given location. The comets were both observed until 30 November. The Jesuits continued to make angular measurements of 1618 II until 12 January, 1619.

However, Father Kirwitzer's treatise contains only the record of observations, at times adding a phenomenological description. There is no theorizing about comets and nothing about what they are, where they came from or where they belong. While summing up, Kirwitzer (1620, 24) notes that

> For a fuller understanding of those observations, it remains to make known the true longitude and latitude of the places where the observations have been done. However, we have not seen yet any Moon Eclipse and from others nothing we learned that we can accept with confidence, we will work diligently in order no latitude and longitude of this or other places of Asia remain unknown . . .

The credit for the first use of a telescope in India for astronomical observations has until now belonged to Jeremiah Shakerley (1626–1655). He had specially come to India to observe the transit of Mercury of 3 November 1651 from Surat in Gujarat. What telescope, timing device and the method of observations he used is not known (see Kochhar, 1989).

For further details of the research discussed here see Kapoor (2016).

Acknowledgements I am grateful to Dr. Sabino Maffeo S.J., Professors Anna Reale and Armando Reale, who translated on request a major portion of Father Kirwitzer's treatise from Latin to Italian and to Dr. Richard Boyle S.J., Vatican Observatory, for all his help in this matter. For any errors in my translation of it into English including my own directly from Latin to English and the final adoption here, the responsibility is solely mine. I thank Dr. R. Vasundhara for correspondence on critical visibility of comets. Thanks are due to Dr. Baba Varghese, Indian Institute of Astrophysics (IIA), for preparing the outline map of India marked with specific locations and to Mr. Manu Kapoor for crucial help at the computer. I thank the Werner Forman Archive/Naprestek Museum, Prague, for providing an image of a margin drawing from the folio of Jahangir's Album (IDS Ref: 55403395-67).

Many papers and images, works on history and the history of astronomy not otherwise available in hard copy were accessed through the Internet.

Finally, I thank the referees for their useful comments and Professor Wayne Orchiston for help that made the manuscript presentable.

References

Kapoor, R.C., 2016. Nūr ud-Dīn Jahāngīr and Father Kirwitzer: the independent discovery of the Great Comets of November 1618 and the first astronomical use of the telescope in India. *Journal of Astronomical History and Heritage*, 19, 264–297.

Kirwitzer, V., 1620. *Observationes Cometarvm Anni 1618. In India Orientali Factæ A Societatis Iesv Mathematicis in Sinense Regnum Nauigantibus ex itinere eo delatis*. Ursellis, Schönwetter.

Kochhar, R.K., 1989. Transit of Mercury 1651: The earliest telescopic observation in India. *Indian Journal of History of Science*, 24, 186–192.

Kronk, G.W., 1999. *Cometography. A Catalogue of Comets. Volume 1 Ancient – 1799*. Cambridge, University Press.

Registrar General & Census Commissioner, India. Census of India 2011 Madhya Pradesh, District Census Handbook Jhabua, Series – 24, Part XII – B, Directorate of Census Operations, Madhya Pradesh. Government of India (2015).

Rogers, A., and Beveridge, H. (transl.), 1909. *The Tuzuk-i-Jahangiri*, *Volume I.* London, Royal Asiatic Society.

Rogers, A., and Beveridge, H. (transl.), 1914. *The Tuzuk-i-Jahangiri, Volume II*. London, Royal Asiatic Society.

Schreiber, J., 1904. Jesuit Astronomy. II. *Popular Astronomy*, 12, 94–112

The comets of 1618. *Nature*, 17, 247–248 (1878).

Vsekhsvyatskii, S.K., 1964. *Physical Characteristics of Comets*. Jerusalem, Israel Program for Scientific Translations.

Williams, J., 1871. *Observations of comets from B.C. 611 to A.D. 1640.* London, Strangeways and Walden.