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COMET TALES FROM INDIA: THE GREAT SEPTEMBER COMET OF 1882 (C/1882 R1)

R.C. Kapoor
Indian Institute of Astrophysics, Koramangala, Bengaluru 560034, India.
E-mails: rckapoor@outlook.com and rck@iiap.res.in

Abstract: This paper brings together India-centric accounts of the Great Comet that appeared in 1882. It grew to be the most magnificent one seen since the Great Comet of 1843, and was observed from throughout the Indian Subcontinent. The comet of 1882 has been variously designated as the Great September Comet, 1882 II, 1882b and C/1882 R1. We look into the observations of the comet made in India by persons of diverse backgrounds, namely, by Norman Pogson, Major G. Strahan, Dr Mahendralal Sircar, A.V. Narsinga Rao, James Burrell Smith and J. Philaire, from different locations. The Madras Observatory observations stand out with Norman Pogson noting the pre-perihelion dual nature of the nucleus before it was reported elsewhere.

Keywords: Comet Tales from India, Great September Comet of 1882, Comet C/1882 R1, Madras Observatory, George Strahan, Norman Pogson, Narsinga Rao, Mahendralal Sircar, James Burrell Smith

1 INTRODUCTION

Although the subject of comets has received space in a few old Indian astronomy texts, the description remains confined only to their morphology and the ominous implications. Nowhere is there an allusion as to a specific comet or even a hint that some real time observations were made. Varāhamihira (CE 485 – 587) has in the *Brhat Samhitā* (CE 505) a chapter '*Ketuchāra*' that is about *ketus* (comets), some of which, he says, are terrestrial and some celestial. Ironically, there are no real-time comets here. Cross-checking with Kronk's (1999) *Cometography* (Volume 1), 33 comets appeared during Varāhamihira's lifetime. He may not have observed them all but he could not have missed ones like Comet 1P/Halley that visited in CE 530. There is no commentary on it from any other quarters in India either. We find *déjà vu* in the *Adbhutasāgara* by the King Ballāl Sena of the Sena Dynasty who commenced its composition in CE 1168 (and it was completed by his son Lakshmanasena). The *Adbhutasāgara* mirrors the *Brhat Samhitā* in its treatment of *ketus*, with nothing on any of the comets in the times of the Senas, e.g., the Comet 1P/Halley in CE 1145, etc. The observations of comets from India that figure in the historical accounts, with however fleeting a reference, can be traced back to the sixteenth century only when stray references begin to appear in literary works and the chronicles, and later in the travelogues and even in the scientific literature (see Kapoor, 2018a).[1]

There are several published accounts of comet observations made in India since the seventeenth century that have some scientific merit. In this paper I provide India-centric stories relating to the very interesting comet that appeared in the year 1882. This was a bright daytime comet that became famous as the 'Great September Comet' (see Figure 1) and turned out to be the most spectacular ever since the Great Comet of 1843. This comet has been previously designated 1882 II and 1882b, and is now known as C/1882 R1. It was followed extensively from throughout the world, but observations of it from India were only reported by relatively few people, many of them astronomers. Full details of the international observations are to be found in the books by Vsekhsvyatskii (1964: 265 – 267) and Kronk (2003: 503 – 516).

The Great September Comet was observed in India, by a few astronomers with telescopes, from different locations. Incidentally, two other comets were seen that same year. One of these, designated C/1882 F1, also was observed at Madras Observatory. This comet was discovered in the constellation of Hercules by C.S. Wells of Albany, USA, on 18.37 March and was last observed on 16.75 August; it passed perihelion on 11.0296 June (Kronk, 2003: 496 – 503). In his Administration Report of the Madras Observatory for the year 1882 Pogson (1883) mentions observing this comet on four mornings in June 1882. No other information is given. In fact, in just one line, he writes of the observations having been made of two comets, namely C/1882 F1 (Wells) and C/1882 R1 (the Great September Comet). About the latter, Pogson (1883: 1) wrote: "… and the great Comet, long so conspicuous to the naked eye, was also observed on thirteen mornings in September and October."

Before we describe observations of the Great September Comet of 1882 from India, it is desirable to provide a brief description of Madras Observatory and the equipment there, particularly during Norman Pogson's Directorship.

Figure 1: The Great September Comet, imaged on 07 November 1882 by Sir David Gill at the Royal Observatory, Cape of Good Hope, South Africa (http://www.saao.ac.za/fileadmin/template/gallery/1882Com200.jpghttp://www.saao.ac.za/public-info/pictures/comet/).

2 MADRAS OBSERVATORY

Madras Observatory was the first modern astronomical observatory to be established in India. Originally it was a private facility set up at Egmore in Madras (now Chennai) in 1786 by William Petrie (d. 1816), an officer with the East India Company (Kochhar, 1985a; 1985b) and a keen amateur astronomer (Phillimore, 1945: 171). Petrie's intention, expressed years later in a memorandum of 04 September 1804 to the Governor of Madras was

> … to provide navigational assistance to the company ships, and help determine the longitudes and latitudes of the company territories. (Madras MS Records: 76).

According to Kochhar (1985a, 1985b), Petrie possessed the following scientific instruments:

1. Three 2.75-inch achromatic telescopes of 42 inches focal length by John Dollond (1707–1761; King, 1979);
2. An astronomical clock with compound pendulum by John Shelton (Clifton, 1995) similar to the one used by Lieutenant James Cook in his 1769 transit of Venus expedition (Howse and Hutchinson, 1969) and later, in 1900, moved to Kodaikanal Observatory —where it is still ticking (Kochhar, 1987);
3. A quadrant by John Bird (1709–1776; Hellman, 1932); and
4. A 20-inch focal length transit instrument by John Stancliffe (Andrews, 1996: 231).

The longitude of the Observatory was determined from observations of eclipses of the Jovian satellites. The first observation on record, on page 164 in the *Madras MS Records* at the Indian Institute of Astrophysics Archives, dates from 5 December 1786 and pertains to the determination of the coordinates of Masulipatam Fort Flagstaff from such observations. Early in 1789, Petrie prepared to proceed on leave and made an offer to gift his observatory to the Government. Michael Topping (1747–1796) saw merit in the proposal (Phillimore, 1945: 171). The Directors of the East India Company (EIC) gave consent in 1790 for — "… the Establishment of an Observatory at Madras … [that] would be of very great advan-

Figure 2: The Madras Observatory at Numgambakkam during the period 1860–1890 (courtesy: Indian Institute of Astrophysics Archives).

tage to Science." Topping was the Company's new Astronomer and Marine Surveyor. In 1792 the Observatory was moved to new premises at Nungambakkam designed by Topping and renamed Madras Observatory (Figure 2).

Madras Observatory initially came to serve as the point of origin for the work on the trigonometrical survey of southern India initiated by the East India Company. From 1818 it was called the Great Trigonometrical Survey of India, and was intended to cover the entire Indian region (Kochhar, 1991: 1928). A precise determination of the longitude of the Madras Observatory was thus essential, so that longitudes required during the survey could be measured. William Lambton began the survey at Madras on 10 April 1802 when a baseline measurement relating to the longitude of Madras was made (Bappu, 1986).

Beginning 1793, there also commenced at the Observatory systematic meteorological measurements by John Goldingham. In 1804, the Observatory received a 12-inch Troughton circular altazimuth instrument, and in 1830 it acquired a 5-feet transit instrument, a 4-feet mural circle and a 5-feet equatorial telescope, all by Dollond (Kochhar, 1985b). As was the norm for British colonial observatories at this time, research at the Madras Observatory focused on positional astronomy. However, Solar System objects and events, and occultations of the fixed stars and planets by the Moon were also of interest. Madras Observatory initiated a unique service to provide a local time service. The Observatory continued to contribute to astronomy under subsequent Directors.

In his book *A Memoir on The Indian Surveys*, the noted British geographer Sir Clements Markham (1830–1916) has this to say:

> The Madras Observatory is now the sole permanent point for astronomical work in India, and the only successor of the famous establishments founded by Jai Sing. It has been presided over by a succession of six able and accomplished astronomers, it has produced results which entitle it to take rank with the observatories of Europe, and its present Director is engaged in the prosecution of labours which are of great importance to astronomical science. (Markham, 1878: 340).

The Director referred to in the above quote is Norman Robert Pogson (Figure 3), who occupied the position from 1861 until his death on 23 June 1891. Pogson started his career as an astronomer at George Bishop's South Villa Observatory in London where he trained under John Russell Hind (1823–1895). Then followed

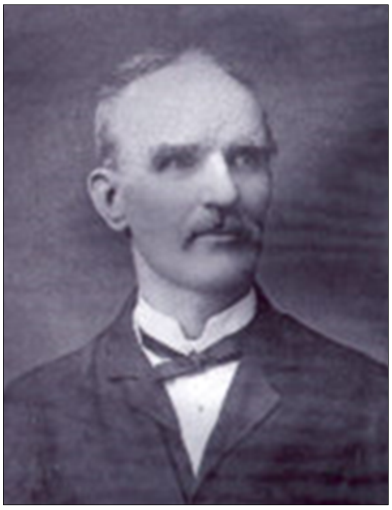

Figure 3: N.R. Pogson, 1829–1891 (IIA Archives).

fruitful days at the Radcliffe Observatory in Oxford from the close of the year of 1851, and at the Hartwell Observatory, beginning 01 January 1859. Although his name is well known as the founder of the modern logarithmic magnitude scale (Pogson 1856b: 12–15; cf. Reddy et al., 2007), while at Madras Observatory, he used the new 8-inch Cooke equatorial to discover five asteroids and seven variable stars (Bappu, 1986; cf. Kapoor, 2010). At Madras, he also re-discovered the lost asteroid Freia (Dreyer, 1892). In addition, his assistant C. Ragoonatha Charry (1828–1880), made a notable astronomical discovery in January 1867 that R Reticuli was a variable star (Bappu, 1986; Markham, 1878: 333–334; cf. Rao et al., 2009). Pogson was honoured with the Lalande Medal for his discovery of asteroid (42) *Isis* on 23 May 1856 at the Radcliffe Observatory (Pogson 1856a), and there is a lunar crater in his name and an asteroid (1830) named *Pogson*. The entry for (42) *Isis* in the *Dictionary of Minor Planet Names* (Schmadel, 2009: 15) makes interesting reading about how the asteroid got its name. This asteroid was Pogson's first discovery. The part of the river Thames that flows through Oxford is called *Isis*. It was suggested by Brian Marsden that possibly Pogson named his daughter after the river. The new asteroid was named by Manuel Johnson (1805–1859), the Director of the Radcliffe Observatory (who was officially called the 'Radcliffe Observer'). (42) *Isis* was probably also named for the discoverer's daughter (b. 1852). In 1860, Pogson was elected a Fellow of the Royal Astronomical Society and on 01 January 1878 was created a *Companion of the Indian Empire.* The crater complex located at 42°.2 S, 110°.5 E near the Lebedev crater on the far side of the Moon was approved by the International Astronomical Union in its XIV General Assembly in 1970 to be named after Pogson. One can find more about Pogson in Dreyer (1892: 235–238).

Figure 4: The Madras Observatory monument (photograph: R.C. Kapoor, July 2011).

Madras Observatory continued in its work during and following Pogson's tenure. It moved to Kodaikanal in 1899 and in 1971 evolved into the Indian Institute of Astrophysics (IIA). From 1899 Madras Observatory focused on meteorology; the only astronomical work that continued was to provide a time service, and this ceased in 1931.

Today at the site of Madras Observatory there is very little to indicate the former presence of an observatory. There is a monument (Figure 4), called 'Monuments (1792)' in the India Meteorological Department (IMD) document of 1976 (Alvi, 1976: 9), that was preserved in its present form in 1948, and a small building (Figure 5) in the grounds of the Regional Meteorological Centre at College Road, Nungambakkam, in Chennai. The photographs shown in Figures 4 and 5 were taken in July 2011. The surrounding greenery with flowering plants and trees is just stunning.

There is a granite slab in the left corner of the platform of the Monument (Figure 4) that has an inscription in Latin, which is shown in Figure 6. In 1792 this inscription originally was mounted on the southern wall of the Observatory room. The text in the inscription says:

> ASTRONOMIÆ consecratum sumptibus Societatis Anglicanæ in INDIA mercaturæ faciendæ favente CAROLO OAKELEY Bar:to Præfecto Præsidii Sancti Georgii A.D. MDCCXCII.

The English translation is:

Figure 5: The remains of a Madras Observatory laboratory building (photograph: R.C. Kapoor, July 2011).

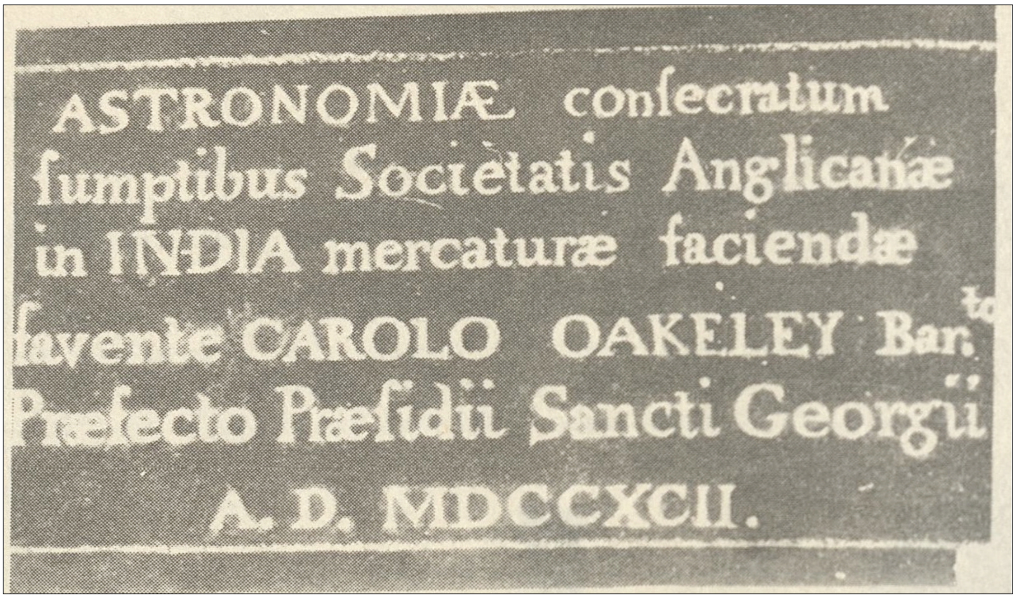

Figure 6: The Latin inscription on the 'Monument', Regional Meteorological Centre, Nungambakkam, Chennai: adopted from Alvi 1076: 10.

> English Society conducting trade in INDIA dedicating the expenses for Astronomy with the favour of Baronet CHARLES OAKLEY Commandant Fort St. George A.D. 1792.

The 10 tonne, 18-feet high granite pillar originally was in the centre of the Observatory building; at its base it measures 4-feet in diameter and it is 2-feet at the top. It was erected by Sir Charles Oakley, the then Governor of Madras. Its top carries the name of Michael Topping, the Chief Surveyor who had designed the Observatory. Originally, atop the pillar was a 12-inch Altitude and Azimuth Instrument by Troughton. The construction was done so that the instrument remained free of vibrations. The pillar has on it the Latin inscription translated into Tamil, Telugu, English and Persian. For details of the development of modern astronomy in India see Kochhar and Orchiston (2017).

3 THE GREAT SEPTEMBER COMET C/1882 R1 (1882 II)

The Great September Comet was seen first on the morning of 01 September by sailors aboard an Italian ship in the southern latitudes. More reports of its sightings from the southern latitudes followed. On 05 September it shone as bright as Venus while on 07 September, the nucleus itself reached about -10^m in brightness. The first astronomical observations were made by W.H. Finlay at the Cape Observatory, and by Australia's leading astronomer, John Tebbutt (see Orchiston, 2017), from Windsor, near Sydney on the morning of 08 September, and subsequently by others. The comet passed its perihelion on 17.724 September at which time its brightness is variously estimated to have been anywhere between -7^m and -17^m (Full Moon: 28 August, 27 September). For a q = 0.00775 *au*, it was surely a sungrazer. By the end of September, it showed up with two elongated nuclei. The earliest indication of nuclear splitting was noted in the observations made on 30 September when it was seen as two elongated nuclei (Vsekhsvyatskii 1964: 266). By 17 October, the nucleus had at least five condensations, and the comet had developed an anti-tail. For many months, the comet was a grand sight, and it remained a naked-eye object until the beginning of March 1883 (Vsekhsvyatskii, 1964: 265).

The Great September Comet led to the start in 1887 of an ambitious international astronomical project, known as the *Carte du Ciel* and Astrographic Project (see Turner, 1912). This involved photographing the whole sky and cataloguing and mapping the positions of millions of stars down to the 11th or 12th magnitude. This project lasted many decades and involved twenty observatories from around the world. It also led to the foundation in Kiel, Germany, of the Central Bureau for Astronomical Telegrams (CBAT) in late 1882 by the editors of *Astronomische Nachrichten* when a need for a co-ordinated centre was felt for a fast and proper dissemination of information.

On 16.98 September, Tebbutt could view Comet C/1882 R1 in broad daylight, even though it lay only 4° west of the Sun. By this time, the comet was rapidly approaching the Sun. At the Cape of Good Hope, W.H. Finlay made the followed observations:

> On Sunday, Sept. 16 to 17, the comet was visible all day … In the afternoon, I watched the comet with the 6 inch equatorial, and power 110, using a neutral-tint wedge on account of the glare of the Sun. I did not expect the comet would reach the Sun before night, but they were rapidly approaching one another, and about 4.40 p.m. I found the Sun's limb visible at the edge of the field ... By keeping the Sun's limb at the edge of the field I was able to follow the comet continuously right into the boiling at the limb. (Finlay, 1882: 21–22).

Elkin (1882: 22–24) also followed it up using the great Indian theodolite and saw the comet vanish in the undulations of the limb of the Sun. Just as they continued to look for it, the Sun sank low and vanished behind the hills. What is interesting is that these were live, day-time observations of the transit of a comet across the Sun that happened between 17.65 September and 17.69 September (≡ 1^h 17^m), a circumstance that had not been witnessed before. The transit was soon followed by the perihelion passage at 17.724 September and then, an occultation of the comet by the Sun between 17.79 September and 17.87 September, lasting 118 min.

It was only after its transit, the perihelion passage and occultation by the Sun that the comet emerged from the glare of the Sun and observations from the northern latitudes began to be reported. On 24 September, its tail was measured to be anywhere between 15°–25° and a tail width ~1°. The comet was well observed in the following months and was last seen on 1.97 June 1883 (Kronk, 2003: 503).

For a large angle of inclination i = 142º.0112, the comet approached the plane of the ecliptic from below. JPL's Small Body Data Browser provides orbital elements for four components of the comet, viz., C/1882 R1–A, C/1882 R1–B, C/1882 R1–C and C/1882 R1–D. For all the components, the date of perihelion passage, September 17.724100001, 1882 is common but the respective i, e and q values slightly differ. There is a greater spread in the q values and thus in the period of revolution, that is given respectively as 669, 759, 874 and 952 years.

The outline map of mainland India in Figure 7 shows the locations referred to in this paper, including those from where the comet was observed.

4 THE OBSERVATIONS OF THE GREAT COMET FROM INDIA

4.1 Observations by Major George Strahan

Major George E. Strahan, Royal Engineers, of The Great Trigonometrical Survey of India observed this comet in the clear skies of Mussooree (6,700 feet) in the Shivalik Hills, in Uttarakhand.

In a communication dated 01 December 1882, from Calcutta to the *Monthly Notices of the Royal Astronomical Society* (henceforth

Figure 7: The outline map of India's mainland, marked with the locations mentioned in the text.

MNRAS), Strahan sent along a set of five sketches of the comet head (Figure 8) made on 28 and 30 September, and on 2, 6 and 10 October (Strahan 1883: 321) all of which show a bright, elongated nucleus and a dark streak below it in evolution. He noted that

> I had intended making a much longer series of them, but the changes in the comet's appearance after Oct. 10 were so trifling as to make it hardly worthwhile. The instrument used was a Browning-With Reflector, with an aperture of 8¾ inches, and power of 160. Unfortunately I had no micrometer available; the dimensions are, therefore, merely estimations.

There is very little information on George Strahan himself except that he was the brother of Charles Strahan, RE (Strahan 1903: 154) who later rose to be the Surveyor General of the Survey of India for the period 1895–1899 (Survey of India 2019). Thackerey (1900(v): 129) in his biographical account of thirty-four distinguished officers "… many of whom ... attained

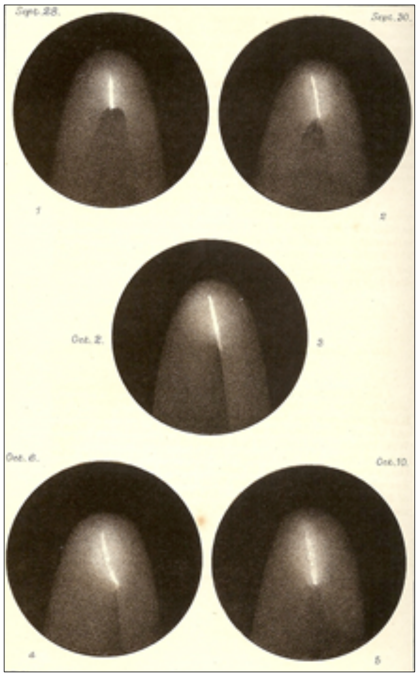

Figure 8: Strahan's (1883) sketches of C/1882 R1.

to the highest positions as soldiers, administrators, or men of science …" and had served in India and other countries mentions of the Strahan brothers being among the twelve officers who had participated in the Bhutan War of 1864–1865. Back in 1874 George Strahan had observed the 09 December 1874 transit of Venus from Lahore (Kapoor, 2014).

A decade after observing the 1882 comet, Strahan (1893) also published a catalogue of 245 stars for the epoch 01 Jan 1892 out of the accumulated astronomical observations made in the course of the geodetic survey of India. The tables include the name of the star, its magnitude, name of the *Nautical Almanac* comparison star, annual precession and proper motion, apart from the Mean Right Ascension and the Mean North Polar Distance. An account of Strahan's topographical survey can be found in Markham (1878).

George Strahan (1886) also wrote about the meteor shower that was observed from Agra on the evening of 27 November 1885.

4.2 Observations Made at Madras Observatory

In his Administration Report for the year 1882 Pogson (1883: 1) stated that

> The unexpected appearance of five comets, three of which possessed unusual interest, and the circumstance of seven of the minor planets discovered by the Astronomer coming into opposition and therefore requiring observation, were unavoidable interruptions during the year. Otherwise the proceedings of the Madras Observatory were as much as possible limited to the ordinary routine work of the establishment, with a view to completing the star catalogue in hand and promoting early publication of all past works.

He put down in just one line the observations made of two comets, namely, the one discovered by Wells (C/1882 F1) and the Great September Comet (C/1882 R1). About the latter, Pogson wrote: "… long so conspicuous to the naked eye, was also observed on thirteen mornings in September and October."

Pogson's observations are important from the point of understanding the elongation and splitting of the nucleus, that other observers reported later. Pogson commenced his observations on 11 September, and he observed the comet until 01 November, but he did not publish these observations. He used an 8-inch Troughton and Simms equatorial refractor, with a 95× eyepiece and he is said to have measured the positions of the nucleus (but it is not clear whether he actually made micrometric observations or he simply estimated the position of the nucleus with respect to adjacent stars).

What is remarkable about his observations is a peculiar reference that he made to an *upper* or *eastern* nucleus, implying that there was also another component of the nucleus he had noted (Rao et al., 2007). Importantly, the splitting occurred prior to the perihelion passage of the comet. Rao et al. (ibid.) extracted details from Pogson's unpublished observational data sheets and notes in the possession of the IIA Archives and they analysed his observations. These are suggestive of the pre-perihelion duality of the nucleus, but Pogson does not actually state that the nucleus had split. Yet Pogson was a seasoned and an accomplished observer, with observations of several comets to his credit made while he was at the Radcliffe Observatory and while at Madras. He knew that some comets were known to split after they passed perihelion. He had observed this in the case of Biela's Comet in 1872, which he had recovered (see Pogson 1872). Notably, in the case of the 1882 comet, other observers did not comment on the elongation of the nucleus until the end of September, yet in his data sheets of "*Madras Equatoreal Observations, 1882 September 11*" (IIA Archives), Pogson tabulates his observations of the "Upper or Eastern Nucleus of Comet" made on different dates, entering in his handwriting also the LST, LMT, RA and NPD, refraction etc. In the data sheet for 24 October, he noted that

> The Comet was much fainter and its two nuclei often scarcely to be distinguished from the Coma. The dome stuck fast on opening it and so the length of the Comet's tail could not be measured.

From the data sheets and the notes, it is not clear if Pogson also made drawings of the comet.

David Gill (1883: 320), Director of the Royal Observatory at the Cape of Good Hope, maintained that the nucleus of C/1882 R1 was single until 28 September, based on a series of drawings of the comet made by different observers. For the powers their optics offered, the nucleus of the comet appeared single. The morning of 29 September was clouded out, but on 30 September Finlay noted that "There seem to be two balls of light in the head …" while Elkin found the same morning the comet's nucleus elongated. Finlay's sketch of 01 October shows individual nuclear fragments joined by a streak of light (Gill 1883: 320).

Rao et al. (2007) reasoned that the nuclear splitting seen only by Pogson was poss-

Table 1: Pogson's observations of the 'upper nucleus' on 11 September 1882.

RA	NPD	LST (hms)	LMT (hms)
10h 06m 9.0s	90° 42′ 04″	04 52 6.44	17 28 29.9

ibly caused because of a baseline of 6,400 km that separated him from the observers at the Cape. That provided him the parallactic 8″ corresponding to the geocentric distance of 0.5 *au* of the comet and he could see in the 10 km nucleus of the Comet a different facet that other observers missed.

Using the Horizons System, I repeated the calculations made by Rao et al. (2007), and derived the values by referring to those shown in Table 1 for Pogson's first observations made on 11 September.

The LST of his observation of 11 September is 4^h 52^m 6.44^s. Choosing John Warren's Madras Observatory coordinates as 13° 05′ 24″ N, 80° 17′ 21″ E (Phillimore, 1950: 195), this observation corresponds to the time of 00:11:18 UT. Accordingly, the comet ought to have been at Alt = 11º 2′ and Az 93º 18′ (N-E). For Madras/Cape Town as the topocentric centre, the ephemerides of the comet components C/1882 R1–A and C/1882 R1-B, generated using the Horizon's System for the time of observation 00:11 UT, are shown respectively in Table 2.

Here, *r* is the heliocentric distance of the comet, and *Δ* that from the Earth. The computed comet positions are apparent and with respect to the Earth true equator and the meridian containing the Earth true equinox of date. Table 2 lists the values as if C/1882 R1-A had been simultaneously observed from Cape Town also on 11 September 1882 at 00:11 UT. There are respectively 0.2^s (≡ 3″) and 6″ difference in the RA and declination values. For the distance of the comet, Δ = 1.0922 *au* at the time and for the Madras–Cape Town baseline of 8,354 km (http://www.wolframalpha.com/), we have allowing for the curvature, a parallactic angle close to 10″. This value is non-trivial and, as suggested by Rao et al. (2007), the geographical separation may have been the cause for the nucleus to be seen from different perspectives.

For context, we present in Table 3 the positions of a few Solar System objects on 11 September 1882 as observable from Madras at 00:11 UT, using John Walker's *Solar System Live.* Here, the distance to the Moon is in units of Earth Radii (ER). That day, the Sun rose at Madras at 00:29 UT. There would have been virtually no interference in the comet's observations from a thin crescent Moon that was just about 7º to its north. The New Moon was to be on 12 September.

Note that just about a year later, Pogson (1884) observed the Comet C/1884 A1 and even published his observations. This comet had been discovered by the accomplished Australian amateur astronomer David Ross (Orchiston and Brewer, 1990) from Melbourne, Australia, on 07 January 1884. Galle was able to view the comet with the naked eye at the time of discovery. The comet had passed perihelion on 25.611 December 1883, two weeks before its discovery, and was last observed on 19 February 1884 (Vsekhsvyatskii, 1964: 269).

4.3 Observations Made by A.V. Narsinga Rao

There is a published account of the Great September Comet by the Indian amateur astronomer A.V. Narsinga Rao (Anglicised as Nursing Row; Figure 9) who observed it from Vizagapatam (now Visakhapatnam). He was the son-in-law of G. Venkata Jugga Row (1817–1856), an affluent *zemindar* (landlord), and also a great astronomy enthusiast.

As one keen to pursue astronomy with modern equipment, G. Venkata Jugga Row was a pioneer in India. His interest saw the construction of a private observatory in the

Table 2: Calculated parameters of C/1882 R1-A and B.1882 R1-B for Madras and Cape Town at 00:11 UT on 11 September 1882.

	RA	Dec	*r*	*Δ*	Alt (°)	Az (°)
Madras (13° 05′ 24″ N, 80° 17′ 21″ E)						
C/1882 R1-A	09h 56m 59.72s	–00° 46′ 47.3″	0.3841	1.0922	13.1629	93.9410
C/1882 R1-B	09h 56m 59.46s	–00° 46′ 48.8″	0.3841	1.0922	13.1639	93.1417
Cape Town (33° 47′ 59.6″ S, 18° 28′ 00.1″ E)						
C/1882 R1-A	09h 56m 59.49s	–00° 46′ 41.0″	0.3841	1.0922	–37.6638	122.5047
C/1882 R1-B	09h 56m 59.24s	–00° 46′ 42.5″	0.3841	1.0922	–37.6628	122.5041

Table 3: Calculated parameters of the Sun, Mercury, Venus and the Moon at 00:11 UT on 11 September 1882.

Object	RA	Dec	au	Alt (°)	Az (°)
Sun	11h 16m 21s	+04° 41.6′	1.006	–04.889	84.018 Set
Mercury	12h 32m 02s	–04° 05.7′	1.233	–25.316	88.345 Set
Venus	14h 03m 54s	–14° 44.5′	0.797	–49.278	97.488 Set
Moon	10h 06m 40s	+06° 18.7′	63.4 ER	12.376	86.300

backyard of his residence in Daba Gardens at Vizagapatam in 1840. Before this, he had learnt astronomy from T.G. Taylor, the Astronomer at Madras Observatory (Kochhar and Narlikar, 1995; Rao et al., 2011). Row's observatory continued to function under his successors till the late nineteenth century. He had acquired a Troughton transit circle and a chronometer and the optics for a refracting telescope of 4.8-inches aperture and 5 ft 8 inches focal length. He carried out astronomical and meteorological observations and even determined the latitude and longitude of Vizagapatam.

On a nearby headland referred to as the Dolphin's Nose, Jugga Row had installed a flagstaff to provide time signals for the public that used to be hauled down at nine in the morning to set the time for the station, and for all who lived too far to hear the report of the gun fired from the local fort. Jugga Row had

Figure 9: A.V. Narsinga Rao (www.avncollege.ac.in/aboutus/history.html).

assisted T.G. Taylor at the Madras Observatory in observations of the Halley's Comet in 1835. He had also independently published a paper in 1836 in the *Madras Journal of Literature and Science* deriving the mass of Jupiter as 302 times that of the Earth using motion of its satellites and Kepler's laws of planetary motion (Rao et al. 2011: 1577). This was a simple calculation, but it gave a result not far from the modern value of 317.83 times the mass of the Earth (Allen 1976: 140). Note that the mass ratio as quoted at that time was on the much higher side. For example, the values given by Herschel (1835: 389) for the Earth's and Jupiter's mass in billionth of the Sun's give the same mass ratio as 338.

A.V. Narsinga Rao (1827–1892) had inherited the observatory from Jugga Row. He carried out life-long astronomical and meteorological observations, apart from initiating telescopic photographic work and maintaining the time service. In order to observe the solar eclipse of 18 August 1868, he assembled a 4.8-inch telescope, whose optics the observatory already had. In 1871, the Government discontinued the time-gun firing service from Dolphin's Nose. However, Narsinga Rao came forward to maintain it at his own expense. He used to publish his observations, and he also maintained contact with astronomers like Sir William Huggins (1824–1910) and C. Piazzi Smith (1819–1900), the then Astronomer Royal for Scotland.

Narsinga Rao wrote the following about the Great September Comet, in his communication to *MNRAS*, dated 8 October 1882:

> A comet is now visible in the eastern heavens before sunrise, and is so conspicuous to the naked eye as to attract general attention. It presents a bright planetary disk, surrounded by nebulosity. On applying higher magnifiers this appearance vanishes, the centre of the head not being occupied by a star-like point. The head has a border of light surrounding it on the side towards the Sun, and continued round on each side of the tail. The disk has been undergoing changes of form and apparent diameter for twelve days. The length of the bright part of the tail is between 7° and 8°, above which are narrow rays or streaks of light extending more than 12° – concave towards the south, and shaped like the tusk of an elephant, the thick part being at the greatest altitude. Observing the comet with the naked eye at the seaside the whole tail took nearly an hour to rise. (Nursing Row, 1883: 32–33).

On 07 October, while observing the comet through his telescope, Rao noticed some vibration at the head, and a part of the tail near it lasting just a few seconds. The telescope was clock driven and he initially wondered whether the vibration was instrumental, or even weather-related. After a close check, he concluded that it was neither of these and that his observation was in order. He gave the approximate position of the comet for the morning of observation as: RA $10^h\ 16^m\ 31^s$, Dec 11°. From his observations, he deduced the daily change in the position in right ascension as $3^m\ 5^s$ and in declination about +34′.5 or +35′.

Just for a comparison, the values from the Horizons System for C/1882 R1-A for the date 07 Oct 1882 as at 00:00 UT are RA $10^h\ 31^m\ 41.25^s$, Dec –09° 36′ 02″.9 (apparent).

Earlier at this observatory, Narsinga Rao (1869) had observed the transit of Mercury on 05 November 1868 with the 4.8-inch telescope. He also had observed the transit of Venus on 09 December 1874 with a 6-inch

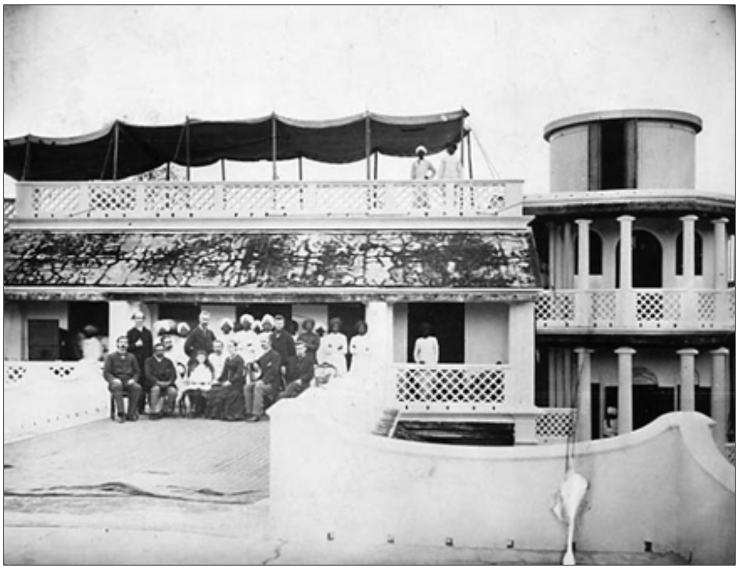

Figure 10: Narsinga Rao's Observatory, Daba Gardens, Visakhapatnam; European and Indian observers of the 1874 transit of Venus (courtesy: Royal Astronomical Society Library).

clock-driven Cooke equatorial refractor (Figure 10), but clouds allowed only the egress phase to be observed (Nursing Row 1875). Today, the site of the observatory is occupied by the Dolphin Hotel, which was established in 1980.

Narsinga Rao's communications to the *Monthly Notices* record also his observations of the solar eclipses of 18 August 1868, 12 December 1871, 6 June 1872 and 17 May 1882; the transits of Mercury of 5 November 1868, 8 November 1881 and 10 May 1891; the transit of Venus of 9 December 1874; and Comet Pons-Brooks (12P/1883 R1) in January 1884 (see Kapoor, 2014). His works speak of a keen interest in and knowledge of astronomy. In 1871, Narsinga Rao was elected a Fellow of the Royal Astronomical Society and the following year of the Royal Geographical Society.

4.4 Observations by Dr Mahendralal Sircar of 'A Comet'

Founded in 1860, St. Xavier's College in Calcutta made a seminal contribution to the promotion of science and technical education in India. The Belgian Father Eugene Lafont (1837–1908) of the Society of Jesus joined the staff in 1865 when he came there to teach. In 1867 he established a meteorological observatory and began working in 1875 to establish also the first astrophysical observatory at St Xavier's College. He had participated in the expedition organised by the Italian astronomer Pietro Tacchini (1838–1905) to observe the transit of Venus on 09 December 1874 from Muddapore (Madhupur) in Bihar (Kapoor, 2014). In the process, Father Lafont discovered the presence of water vapour in the atmosphere of Venus (Biswas, 1994).

Biswas (*ibid*.) details Father Lafont's scientific work at St. Xavier's College and his contribution, together with Dr Mahendralal Sircar (1833–1904; Figure 11), in founding the Indian Association for the Cultivation of Science (IACS) in 1876. With encouragement from Fr Lafont, on 07 March 1874 Dr Sircar acquired Dr J.N. McNamara's telescope, "… a simple instrument without equatorial etc. It has five powers." for Rs. 250 (Biswas 2000: 19). There is no information on the manufacturer or aperture of this instrument, which we can presume

Figure 11: Dr Mahendralal Sircar (after Biswas, 2000).

was a small refractor. Dr Sircar would often observe planets with it.

Dr Sircar maintained diaries of his activities, and the entries for the year 1882 describe observations of a comet. The comet is not identified, but to be worthy of observing and noting it would have to be a reasonably bright comet. The cometary entries in his diaries all date to the period 23 September–09 October 1882, therefore there is no doubt that he was observing the Great September Comet (C/1882 R1). The diary entries, which Biswas (2000: 87) already drew attention to, are all reproduced below:

> September 23: Saw a comet on the east early in the morning at 5.00 a.m. A big one, with long tail. It must be a very brilliant one as it was visible till 5¾ a.m. It was first observed by Gopal's wife. It is to the south and west of the sun.
>
> September 27: Saw the comet well this morning, from 5 to 5.30. Up to 5.40 it was fairly visible. It had begun to be visible at 4.30. At 5½ it was higher to-day than it was on the first and second day I saw it. Hence it appears to have passed the Perihelion.
>
> October 8 (Sunday): Was awakened at 4.00 a.m. by wife to see the comet. It had then risen a few degrees above horizon. This is the 11th day of the moon and consequently near the comet north-west of it.
>
> Notwithstanding the moon, the comet shone with splendour. Saw stars through the end of the tail and one star through the coma around the nucleus. The comet was visible till 5½ a.m. after which both the light of dawn and thin clouds eclipsed it.
>
> October 9: Saw the comet again from a little after 4.00 a.m. to 5½ a.m. Then went out for a morning walk with Nilmani Babu …

These descriptive observations come from a person with a medical background. All of these observations date from before British India adopted two time zones. That happened in the year 1884 and the zones were named Calcutta Time and Bombay Time respectively. Note that the local mean time at Calcutta (= Greenwich Mean Time + $\lambda/15^{\circ}$) was $5^{h}\ 53^{m}$ ahead of the Greenwich time.

Dr Sircar's sole astronomical regret, if we can believe the entry recorded in his diary on 06 November 1874, was that his telescope was not able to resolve Saturn's rings. This was only a month prior to the transit of Venus that he also observed (Biswas, 2000: 26). Nearly a quarter of a century later he observed a total solar eclipse on 22 January 1898, from Dumraon in Bihar.[2]

4.5 A Lithograph of the Comet Based on a Painting by J. Burrell Smith

Presented in Figure 12 is a lithograph titled 'Great Comet of 1882, seen from India'. This lithograph is in the collection of the Science Photo Library of the Royal Astronomical Society (Image: C008/4429) and is reproduced here with permission. The text accompanying the image reads:

> Great Comet of 1882, seen from India. The comet is at upper right, seen in the night sky over a train crossing a bridge. A group of observers is at lower left. This comet was visible from September 1882 to February 1883 …

The signature is 'J. Burrell Smith', but the initial is not very clear. No other details are available, either about the artist or the identity of the place that is featured in the artwork. Nevertheless, the lithograph is valuable, and an observation in its own right.

There are six spectators and a dog in the scene. Their location is on the plains, near a stream, and the time is early morning. Their attire suggests a cold morning. Therefore, the location is possibly in the northern part of India. As for the comet, it was only after the day of its transit across the Sun and immediately thereafter the occultation by the Sun that the observations of the comet from northern latitudes began to come in during September 1882. The Full Moon was on the 27th. The lithograph reflects the situation a few days prior to the New Moon. The head of the comet is depicted several degrees above the horizon. A few bright stars in the sky are also visible, though not in any obvious pattern that reflects a known constellation or a part thereof. There are clouds in the distance, which can be explained by the fact that the observation was made in the month after the SW Monsoon had recently retreated.

For a work of art done in 1882 that bears an India connection, the significance of the depiction of a train and the bridge over a river cannot be underscored. It belongs to the early days of the spread of the rail network in the area the artist likely observed from. The bogies are of a passenger train, and the long masonry bridge here is in fact a viaduct—a series of arched structures resting over tall piers, more than 30 in number, that lends great aesthetic appeal. The sky background suggests that the train was moving from south-to-north. The observers' location is downstream as can be made out also from the reflections.

A search through the web for archival images of the viaducts of the 1880s, including those in Indian railways archives and blogs,

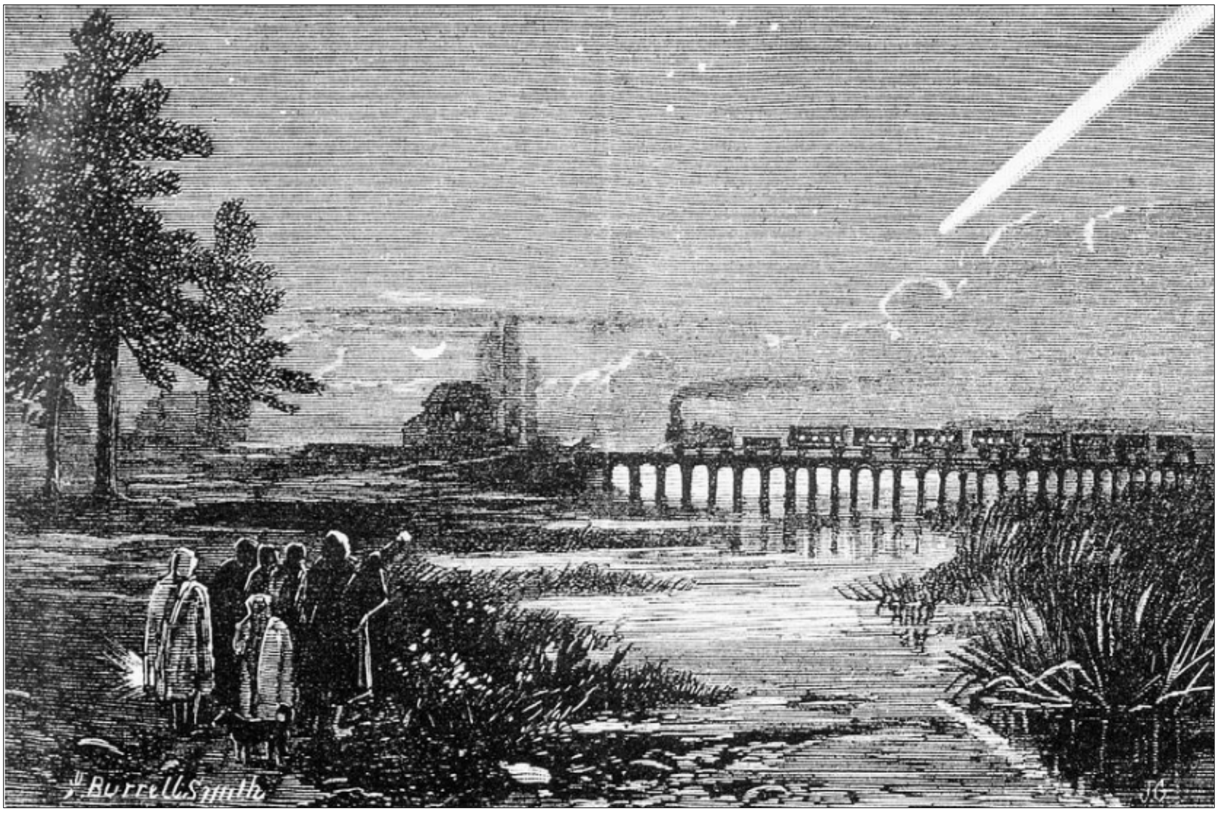

Figure 12: "The Great Comet of 1882, seen from India" (reproduced by permission of the Royal Astronomical Society/Science Photo Library https://www.sciencephoto.com/media/147351/view).

Figure 13: The Kabini Bridge, Nanjangud (2011 image by Suraj, TS; adapted from Wikimedia Commons).

that could have been the subject in Burrell Smith's work bore no fruits.

The viaduct depicted in Figure 12 actually resembles the one in Figure 13–the Nanjangud Viaduct—or the Kabini Bridge between Tandavpura and Nanjangud in Karna-taka that is listed in the Heritage Inventory of the Indian Railways (2016). However, although built in 1735, this one is not a contender as it was only made into a bridge for the railway in 1889.

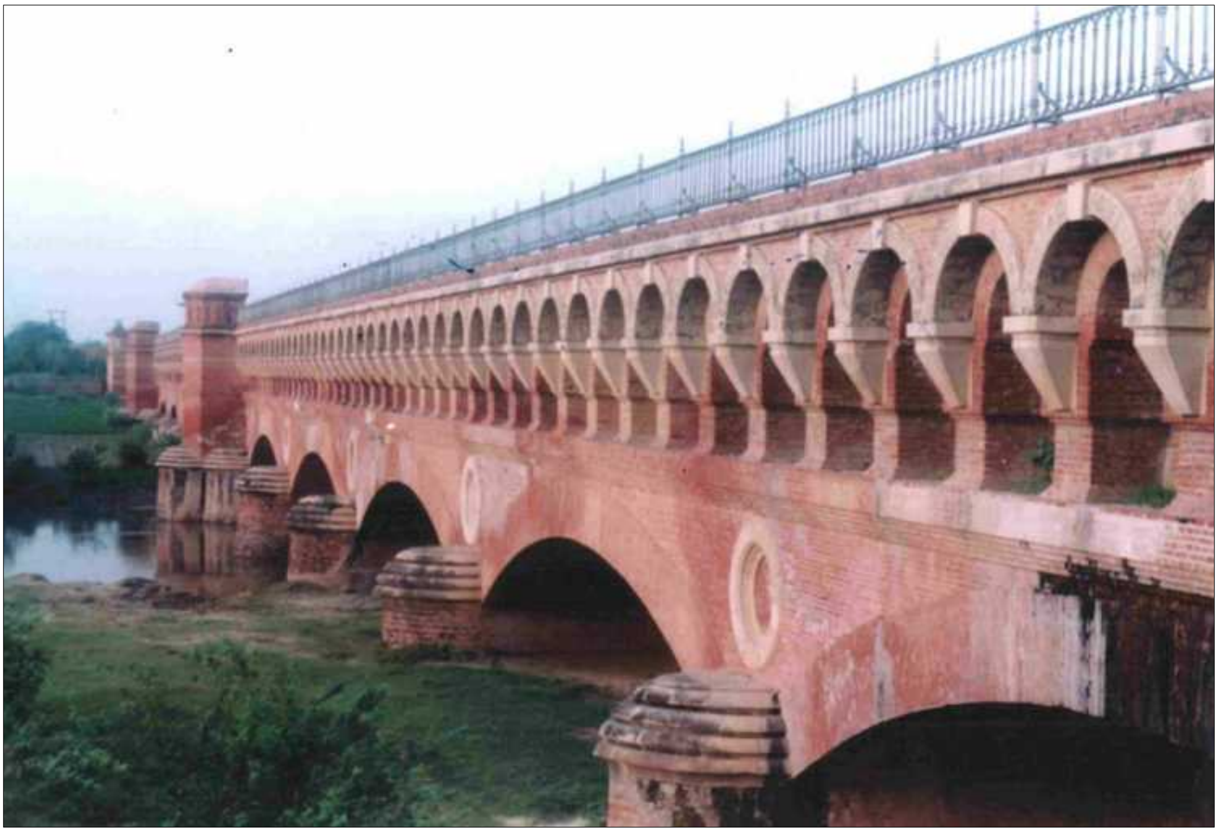

Figure 14: The Solani Aqueduct over the Solani Rivulet, on the outskirts of the city of Roorkee (from: https://www.euttaranchal.com/tourism/solani-aqueduct.php; accessed 23.05.2020).

1889. Needless to say, a large number of the brick masonry viaducts from the second half of the nineteenth century have been abandoned or destroyed, or at best are closed today.

I raised a query about the identity of the viaduct in Figure 12 with the office of the Executive Director/Heritage, Railway Board, Ministry of Railways in New Delhi. In their opinion, there may have been some artistic license taken and that the one that may fit the bill is the Solani Aqueduct (Vinita Srivastava, person comm., 17 February 2020). This aquaduct is over the Solani Rivulet, on the outskirts of the city of Roorkee, and a present-day view is presented in Figure 14. It is a brick masonry structure with 15 spans of length 15.25 m each. In fact, it is the first viaduct built in India and it was here that the first steam locomotive ran on rails. That was to ferry the construction material between Roorkee and a nearby place Peeran Kulleeur (Piran Kaliyar) beginning on 22 December 1851 (Cautley, 1860: 440). This happened two years before the first 14-carriage train, with passengers, ran between Bombay and Thane, on 16 April 1853. Recall that the Amritsar-Saharanpur-Ghaziabad Line was completed in October 1870, providing a connection between Multan (now in Pakistan) and Delhi, and thus facilitated travel to Roorkee (50 km from Saharanpur) that was better known in those days for its Cantonment and the Thomson College of Civil Engineering (which later evolved into the present-day Indian Institute of Technology).

One can see the Solani Aqueduct from a distance while on the way from Roorkee to Haridwar in Uttarakhand. The view is impressive but it being downstream, we actually look towards the west. On the other side is the Upper Ganges Canal[3] as shown in Figure 15, and the Solani Aqueduct is so constructed that seen from that side, the scene as shown in Figure 12 is not visible. Besides, the last train to run on this track was in 1852 (Singh, 2006), and Roorkee itself was only linked by rail in 1886.

True to its name, the Indian Railways Fan Club (IRFCA; see https://www.irfca.org/) maintains an excellent and informative website on the history of the Indian Railways. According to Apurva Bahadur (person comm., 22 February 2020), Moderator with the IRFCA group:

> This bridge could exist even today but probably look different after having being rebuilt with stronger materials. Or as in several bridges in India, a new structure was built parallel to the older one and the track was shifted to the former. In time, the older structure collapsed and was consumed by the annual floods etc. Person-

Figure 15: A watercolor painting "The Ganges Canal, Roorkee, Saharanpur District (U.P.)" by William Simpson (1823–1899) in the British Library. This is a downstream view, as we look towards the north (Wikipedia).

> ally, I can't think of any railway masonry bridge in visual memory with so many arches, with the exception of Nanjangud.

Without knowledge of Burrell Smith's travel history in India during the period 1882–1884, it is difficult to identify the viaduct shown in the artwork and its location.

Can we fix the date of observation? That depends on knowing where the observation was made in India from. For a cold morning, rather than its being a morning a few days prior to the New Moon of 12 September, it is more likely to be the one prior to the New Moon of 12 October. Around then, the comet still had a long tail, of between 15° and 20° (Kronk, 2003: 508). For the reason to be clear in the following, let us assume it to be some place near Calcutta, the then-capital of British India. A computation with the Horizons System places the comet and the Moon in the sky as shown in Table 4.

The values are topocentric, as at Calcutta (22° 34' N, 88° 22' E). The time of the day is 00:00 UT which is arbitrary and just a few minutes before the local sunrise time. The Sun's position is given for 11 October only. Between the dates considered, the positions increasingly get better for 10th and 11th October 1882 when a thinner Moon and the comet have an increasing azimuthal difference so as to fit the depiction, leaving also a scope for a few bright stars to be incorporated. The comet was then in Sextans, below Leo. The stars in the picture could be taken for the tail-side of the lion (Denebola, etc). Obviously, the artist was part of the observing group, but the painting was done somewhat later while the event was still fresh in his memory.

A net-search for Burrell Smith led me to the British artist James Burrell Smith (1822–1897). There is an extensive collection of outstanding paintings in oil and watercolours by him accessible on the web, but hardly any biographical account beyond a few lines. The Wallington Gallery (2019) has the following:

> Smith was born in the south of England and in 1843 moved to Alnwick, Northumberland, where he received tuition from Thomas Miles Richardson Snr. He is well known for his large landscape watercolours with figures. Several of his views are in the collection at Alnwick Castle. James Burrell Smith died in London at West Kensington.

whereas, as per the website of lythamstannes-artcollection (2019):

> He painted landscapes, particularly of river scenes, waterfalls, lakes, often with mountains in the backgrounds and anglers or

Table 4: Relative positions of the comet and the Moon and Sun in October 1882.

Object & Date	RA	Dec	Alt (°)	Az (°)
Comet				
08 October 1882	$10^h 30^m 11.35^s$	–10° 02′ 48.1″	29.0	116.5 N-E
10 October 1882	$10^h 27^m 18.21^s$	–10° 55′ 00.6″	30.7	119.0 N-E
11 October 1882	$10^h 25^m 54.60^s$	–11° 20′ 44.1″	31.5	120.3 N-E
Moon				
08 October 1882	$09^h 57^m 11.15^s$	+06° 58′ 03.0″	44.5	102.9 N-E
10 October 1882	$11^h 26^m 47.88^s$	–01° 16′ 38.7″	22.6	101.5 N-E
11 October 1882	$12^h 11^m 31.26^s$	–05° 24′ 06.2″	11.6	100.9 N-E
Sun				
11 October 1882	$13^h 04^m 49.23^s$	–06° 54′ 13.1″	–1.1	97.0 N-E

small groups of cattle in the foreground. He painted in many parts of England, in particular the Lake District, but also views of Wales and Scottish lochs and castles.

Smith travelled widely on the Continent producing river views such as Cologne on the Rhine (1865) and also scenes of Lake Como and Lake Geneva. He exhibited at Suffolk Street between 1850 and 1881.

Most of Burrell Smith's works are landscapes and bear a thematic commonality—in the form of tree cover, bushes, water streams and lakes, with mountains as background etc. These were done in England and in some places in Europe. One may find many of these featured in the pages of 'invaluable' (2019).

To cross-check the style of James Burrell Smith with the artwork here, one may see the Lot 653 in the webpages of 'invaluable' as an example. The signature in his paintings strongly resembles the signature in the comet artwork here. In the latter, the feature preceding the letter 'B' of Burrell in the artist's signature is not clear but strongly suggests it is the letter 'J'. So, our artist is James Burrell Smith.

As it is with his biography, there is no information available about Burrell Smith's travel, all the way from England to India and being there in 1882. However, there *is* an independent hint to that in another India-centric work attributed to James Burrell Smith, a water colour titled "Kanchenjunga from a ridge a few miles southeast of Darjeeling, India, 1884". It can be found in the webpage of 'artnet' (2019). This painting and his 'comet painting' indicate that James Burrell Smith had indeed been on a visit to these areas of northern India in 1882–1884.

What would have made Burrell Smith visit a place like Darjeeling in the foothills of the Himalayas that until recently would take over a fortnight to reach even from Calcutta? The answer may lie partly in the development that took place with the rail network at this time. Recall that during the 1850s and the 1860s railway construction was undertaken in many parts of India. In 1865, the first train passed over the Yamuna Bridge in Allahabad (now Prayagraj) that became the crucial link between the left bank of the Yamuna at Delhi and the right bank of the Hooghly at Calcutta (Huddleston 1906: 42). By 1870, it had already become possible to travel by rail from Bombay to Calcutta via Allahabad. Indeed, one could undertake travel by rail and sea from Marseilles to Alexandria, then through the Suez Canal, and on to Calcutta, covering about 9,000 km in just six weeks (Lalvani 2016: 200; see also Etemad 2007: 79).

Add to that 600 km by rail from Calcutta to Darjeeling (27°.041 N, 88°.266 E). The start of the two-stage rail link between Calcutta-Jalpaiguri-Siliguri dates from around 1878, and the 83-km narrow gauge (2'-0") rail link between Siliguri at the foothills of the Himalayas and Darjeeling (h ~2070 m) in the hills was established between 1879 and 1881 (The Darjeeling Himalayan Railway, 2019). The construction was a great technological challenge and once it was inaugurated in July 1881 the rail link significantly cut down the travel time to Darjeeling. Although the Hill Cart Road to Darjeeling had opened in 1869, travel on it was a nightmare. The coming of the railway also had a great socio-economic impact and spurred on economic activity in Darjeeling like never before.[4]

At the time, Darjeeling was the centre of a tea-growing region and was famous among the British as a site of recuperation and leisure, and a hill resort that offered heavenly views of Kanchenjunga (8586 m).[5] The newly opened rail-route to Darjeeling possibly drew our artist to this corner of India, and he may even have had an acquaintance there. The dots are only a few, but they are connectible. Meanwhile, back home Northumberland had its own share of viaducts. Painting the Great September Comet of 1882, a viaduct with a train on it and the surrounding flat countryside maybe brought back memories of home to Burrell Smith.

It is interesting that Burrell Smith's lithograph (Figure 12) is often found on the web alongside a very similar one, also signed

James Burrell Smith and titled “The comet as seen in South Africa” (e.g. see https://www.sciencephoto.com/media/147352/view). Here too, the subject is the Great Comet of 1882 being observed by some people in the wilderness. Notably, the comet’s position angle (orientation) is reversed. With none of the features of its Indian counterpart—the train, the viaduct, the Moon and bright stars—this South African rendition pales in comparison to the Indian work. Assuming that Burrell Smith actually painted both pictures from life, a crucial question is how he could have been present in 1882 in two different places a good 8,000 kilometres apart? At the very least, the two observations should be about a lunation apart. We note that around mid-September, the comet was indeed seen by many observers in strong morning twilight, when it had a long tail. According to Eddie (1883: 289) this measured 12° on 13 September when he observed the comet from Grahamstown at the Cape of Good Hope. By the mid-nineteenth century steamer ships were already operating on several international routes (Rootsroutes 2020) and it was possible to travel from London to Bombay, via the Cape, in a month (Etemad, 2007: 79). So the timing was possible, even when we add Burrell’s travel time to his destination within India. He may have chosen the trade-route to India via the Cape *in lieu* of the shorter trip through the Suez Canal (that operated from 1869), because he had an acquaintance he wished to visit in South Africa, or simply because he wanted to see more of the world. While *en route* to Cape Town and India, the comet would have entertained him throughout the voyage.

Was Bombay his Indian port of entry? If that was the case, then the viaduct in his India artwork could very well be the Dapoorie (Dapodi) Viaduct near Pune that he romanticised in the style of one back home. Built in 1854 over the Mula River, this viaduct had 22 × 10 m stone arches (Figure 16). From a close-up of the city of Pune in Google maps, the Mula River in the Dapodi area is seen flowing almost west to east. The major bridges here are the Mula Bridge (18°.5747 N, 73°.8353 E) with a railway track over it and the Dapodi Bridge on the Old Mumbai Road next to it, in a near north-south direction. The values in Table 4 for the comet’s position in the sky on certain dates in October 1882 can apply equally well to the location of the Dapoorie Viaduct.

Figure 16: The Dapoorie (Dapodi) Viaduct over the Mula River, near Pune (courtesy: The British Library; Shelfmark: Photo 254/3(41); Item number: 254341).

The discussion in this Section has focussed more on identifying the viaduct as depicted in Figure 12 and thereby the location of the observation than on the comet itself. That for me is an important aspect in Burrell Smith's Indian work but as the search has borne no fruits, his passage to India and the stay remains disappointingly clouded.

A number of bright naked-eye comets appeared during Burrell Smith's life, including the Great Comet of 1843 (C/1843 D1 Great March Comet), Donati's Comet (C/1858 L1 Donati), the Great Comets of 1861 (C/1861 J1 Great Comet Tebbutt) and 1865 (C/1865 B1, Great Southern Comet), Coggia's Comet (C/1874 H1 Coggia) and the Great Comet of 1881 (C/1881 K1 Great Comet Tebbutt). These comets enthralled the public and astronomers all over the planet. Burrell Smith may have seen all of them, but the Great September Comet of 1882 was the only one that so inspired him that he decided to commit it to canvas.

Figure 17: "THE GREAT COMET AS SEEN AT PONDICHERRY, INDIA" (after *Scientific American Supplement*, 15(383): 6105 (1883)).

James Burrell Smith died on 16 December 1897 in West Kensington, London (Lythamstannesartcollection, 2019).

4.6 Observations Made by J. Philaire from Pondicherry

There is a communication by J. Philaire to the *Scientific American* (1883: 6105) describing observations of the comet of 1882 made from Pondicherry (now Puducherry), along with a photograph (see Figure 17) that the latter published in the Supplement [15(383): 6105] of the journal.

The text of the letter, dated 23 January 1883, reads as follows:

> I have the honor to send you a photograph of the great comet, taken on the quay at Pondicherry, on the 27th of September, at three minutes before five o'clock in the morning. There may be remarked in it very well the brilliancy of the nucleus, the convexity of the tail (which is directed toward the south), the shadowy line that divides the tail throughout its length, and, finally, the slender, rectilinear line that seems to continue the convex part of the tail. This latter remarkable peculiarity has not yet, I believe, been referred to in the articles that have appeared in La Nature.
>
> Nothing can give you an idea of the truly striking spectacle that was offered us by this magnificent star as it rose every morning; and it was not without a genuine emotion that the immense incandescent fascicle was seen issuing from the horizon and rising in the heavens, while a column of fire seemed to glide over the surface of the sea and threaten the observers who were stationed along the shore.
>
> We were favored with superb weather, and, for a number of days, were enabled every morning to contemplate this splendid meteor at our ease. The photograph was taken by a native named Francine. J. PHILAIRE.

The text was accompanied by the photograph shown in Figure 17.

No information about the letter-writer J. Philaire or the photographer Francine could be found. Pondicherry, often referred to as the *Paris of the East*, continued as a settlement of the French in India long after the British had taken control of the whole subcontinent in 1858, and it even remained so after India gained its Independence in 1947, right up until 1954.

5 CONCLUDING REMARKS

The appearance of an unusual object in the sky, its ever-changing form till it begins to overwhelm and turn curiosity into awe and even spurs the superstitions associated therewith all together form the ingredients that make for a sensation of a lifetime. The Great September Comet of 1882 was such an object. The nineteenth century saw a number of Great Comets, beginning with one in 1807, much to the excitement of astronomers and the public alike. Great comets also created excitement among artists and poets, who featured them in engravings and paintings (e.g. see Olson and Pasachoff, 1998), and in poetry, and they were widely reported in newspapers.

Notably, the same Great Comets were observed from India also. A few timed with the early phase of the Indian Renaissance that had begun to put Medieval India on the path to modernity and the people were making social, political and scientific sense of the world around them. The solar eclipses of 1868, 1871 and 1872 and the transit of Venus 1874 brought many eminent astronomers from the West to India, and they helped create public awareness (e.g. see Kapoor, 2014; Kochhar and Orchiston, 2017: 737–746). Therefore, it may appear a little odd that while the Great September Comet of 1882 evoked such an exciting response worldwide, there were only a handful of reports of its observations from India and hardly any from British officers in India. Even the reports that we have been able to access are of the 'also observed' kind. It is only Norman Pogson's Madras Observatory observations of the pre-perihelion dual nature of the nucleus that stand out, as this feature was only noticed by other astronomers later. It is ironical, therefore, that Pogson did not pursue this further or bother to write up and publish his observations. Earlier, when he was in England and was very active in observational astronomy, Pogson did not publish his observations of Donati's Comet (C/1858 L1) either. Who would not be fascinated by a Great Comet in the sky? The answer in the case of Pogson is not clear-cut (see Kapoor 2020).

To some extent Pogson's silence was compensated for by a remarkable work of art, titled "The Great Comet of 1882, seen from India", by the British landscape painter James Burrell Smith, even if there is still a mystery surrounding his visit to India. Its underlying scene is resurgent India. The only thing that can be said with some confidence is that Burrell Smith's painting represents the sky on 10 or 11 October 1882, when a thin Moon and the Great Comet had reached alt-azimuthal distances that correspond to the depiction.

6 NOTES

1. 'Comet Tales from India' is my on-going project since 2009 in the search of records of cometary sightings made from the Indian region, from antiquity until 1960, where available data, however minimal, permit identification of the comet. The work "Comet Tales from India. 1. Ancient to Medieval" (Kapoor, 2018a) covers the period up to 1799. Research on observations of comets made from India in the nineteenth and twentieth centuries is in progress. A few nineteenth century comets that have been dealt with in this series are the Great Comet of 1831 (Kapoor, 2011), the bright comet of 1825 IV (C/1825 N1) (Kapoor, 2016), Donati's Comet (Kapoor, 2018b), the Great Comet of 1807 (Kapoor, 2019a) and the Great Comet of 1811 (Kapoor, 2019b). Donati's Comet also is dealt with in Kapoor (2020).
2. Dr Mahendralal Sircar had observed the total solar eclipse of 22 January 1898 from Dumraon in Bihar. This eclipse was observed by many groups and from many places in India, including expeditions led by John Evershed (1864–1956) and Dadabhai Naegamwala (1857–1938). A party of Jesuits from the Western Bengal Mission led by de Clippeleir, Director of the St. Xavier's College Observatory, had set up a camp at Dumraon in Bihar. They were equipped for photography, photometry and spectroscopy, and the following entries are from the diary of Amritlal Sircar, Dr Sircar's son (Biswas, 2000: 313):

   20 January. Thursday: Left Calcutta by Bombay Mail 6 p.m. for Dumraon to see the total eclipse of the sun. My father, Dr. Hem Chandra Roy Chaudhury, Babu Prabodh Chandra Chatterjee and Namama (Nibaran Chandra Biswas) formed the party. We took a reserved 2nd Class Compartment.

   21 January, Friday: Arrived Buxar at 8 a.m. Dumraon at 11 a.m.

   22 January, Saturday: Saw the total eclipse with our telescope. It is indeed a very grand phenomenon. The corona was very nicely visible. There was not the complete darkness.
3. Colonel Proby T. Cautley, an officer in the British Army was the prime initiator of the Ganges Canal project, the first irrigation project in North India to cater to the Doab region between the rivers Ganga and Yamuna. The project had been prompted by the Agra famine of 1837–1838 that affected a large area and population and made a great transformation in the region. The Upper Ganges Canal commences from the Bhimgoda Barrage in Haridwar in Uttarakhand. Its construction started in 1842, and it was opened in April 1854 (Cautley, 1860). The Solani Aqueduct (Figure 14) was part of the Upper Ganges Canal project (Figure 15). The Lower Ganga Canal begins from Narora in Bulandshahr district.
4. In 1999, the Darjeeling Himalayan Railway

was designated a World Heritage site.

5. There is a Himalayan Mountaineering Institute (HMI) in Darjeeling, a centre since 1954 dedicated to education and research on mountaineering and the preservation of Himalayan art and culture. The HMI Museum was established in 1957, and is of great interest to the tourists for there is a Zeiss telescope that provides a beautiful view of Kanchenjunga. The telescope, said to be suitable for astronomical observations also, was a pre-WW II gift of the German Chancellor Adolf Hitler to the Commander-in-Chief of the Nepalese Army, Maharaja Juddh Shumsher Jung Bahadur Rana. The Maharaja passed the telescope down to his son General Shamsher Jang Bahadur Rana who subsequently presented it to the HMI on 7 July 1961 (HMI, 2020; Kapadia, 2005: 96; Kochhar and Narlikar, 1995: 23).

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Professor Ramesh Kapoor began his career in 1971 at the Uttar Pradesh State Observatory, now the Aryabhatta Research Institute of Observational Sciences (ARIES) at Naini Tal, India, in observational astronomy where his main interest was flare stars. From March 1974 until September 2010, he was with the Indian Institute of Astrophysics (IIA) in Bengaluru, where he worked on various topics in relativistic astrophysics like the observational aspects of black holes, white holes, quasars and pulsars, etc. He has participated as an observer and as an organiser in a few solar eclipse expeditions mounted by the IIA. He has published in international journals and presented papers at national and international conferences. His current research interest is history of astronomy, particularly comet sightings and observations from the Indian region. In addition, he has been active in popularizing astronomy, and he also has published on Indian systems of medicine. He is a member of the International Astronomical Union and a Life Member of the Astronomical Society of India.