Astronomical Instruments presented by the Maharaja of Benares to the Prince of Wales in 1876

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During his tour of India in 1875-76, the Prince of Wales (the future Edward VII, Fig. 1) was presented a highly interesting set of astronomical instruments by the Maharaja of Benares (Fig. 2), Sir Ishwari Prasad Narayan Singh, GCSI, on 5th January 1876. Before discussing these instruments and their importance for the history of astronomical instruments in India, we may dwell briefly on the opulence of the reception accorded to the Prince by the Maharaja in his Ramnagar Fort (Fig. 3), as described by the chronicler[1]:

> 'Shortly before sunset the Prince embarked in a handsome galley, [...] which was towed by a steamer to the old fort of Ramnagar, four miles up the Ganges, where the Maharaja of Benares received the Prince on a canopied and garlanded landing. It was the grandest and the most characteristic reception possible. The river-bank was blazing with the twittering *feux de joie;* the air lighted up by the discharges of artillery from the ancient parapets; the battlements of the fort were illuminated. Silver flambeaux and torches were held by people on parapets, walls and river-banks, which were as light as day. Preceded by mace-bearers, spearsmen, and banners, the Prince and the Maharaja were borne in gold and silver chairs, on men's shoulders, up the ascent from the river to the castle gate, between lines of matchlockmen and cavalry. [...] The Maharaja led the Prince upstairs, where, after the usual presentations and a short conversation, a long file of servitors laid examples of gold brocade and of the famed kinkob[2] of Benares, Dacca muslin, and costly shawls at the Prince's feet, while the Maharaja sat, like a benevolent old magician in spectacles and white moustache, smiling, in his hall, with hands joined in a deprecating way as each tray was laid on the ground, as though he would say, "Pardon that unworthy offering!" The Maharaja then conducted the Prince to a room where other beautiful presents were laid on tables.'

These presents included several astronomical instruments which were certainly not unworthy; indeed, there were historically very significant. A detailed list of these is given at the end of the book, under the heading 'Notes' (p. 616).

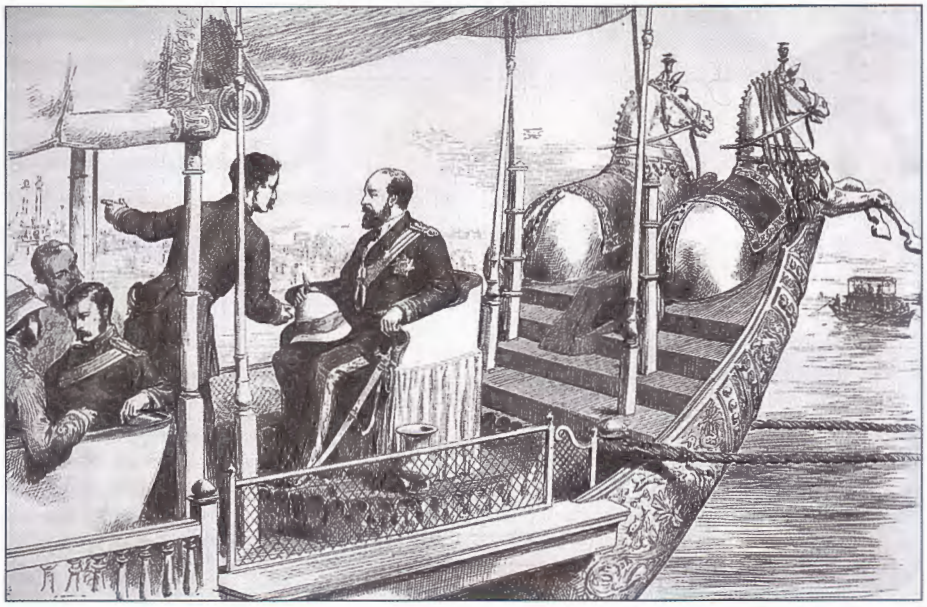

Fig. 1 *The Prince of Wales on board the state barge of the Maharaja of Benares,* The Illustrated London News, *12 February, 1876.*

Fig. 2 *H.H. Maharajadhiraja Sri Sir Ishwari Prasad Narayan Singh Sahib Bahadur, Maharaja of Benares (1822-1889), who received the Prince of Wales (the future Edward VII) on 5th January 1876.*

'Description of Instruments presented by the Maharaja of Benares. The originals of the first five are found in the Hindu Observatory, Benares. Jan. 5, 1876. (Referred to in Page 390.)

1. DIGANSA-YANTRA.—An instrument for finding the degrees of Azimuth of a planet or star.

2. DHRUVA-PROTA CHAKRA-YANTRA (Fig. 4).—An instrument for finding the degrees of declination of a planet or star.

3. YANTRA-SAMRÁT (Prince of Instruments) (Fig. 5). For finding the distance (in time) from the meridian and the declination of a planet and star, and of the sun; and the right ascension of a planet or star.

4. BHITTI-YANTRA (a mural quadrant). An instrument for finding the sun's greatest declination and the latitude of the place.

5. VISHUVAD-YANTRA (the Equinoctial circle) (Fig. 6). An instrument for

Fig. 3 *The frontage of Ramnagar Fort in 1869.*

Fig. 5 *Yantra-samrat* (No. 3 in the list). It is set up in all the Observatories. From Joseph Dalton Hooker, *Himalayan Journals,* p. 69.

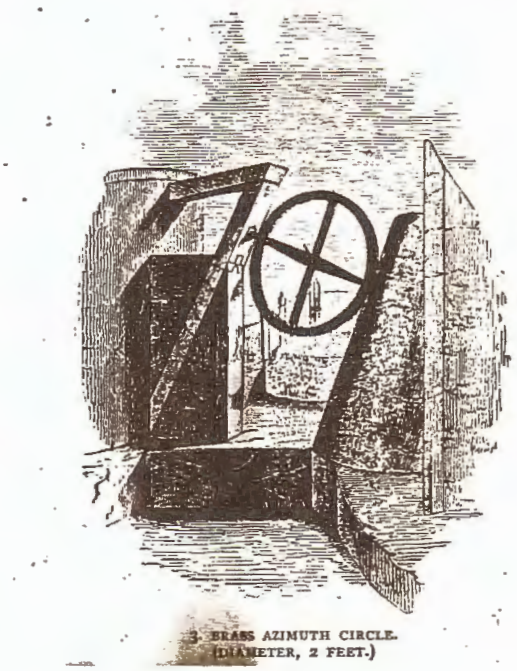

Fig. 4 *Dhruva-prota-chakra-yantra* (No. 2 in the list). Now it is labelled as *Chakra-yantra.* There is another specimen at Jaipur. From Joseph Dalton Hooker, *Himalayan Journals,* p. 70.

Fig. 6 *Vishuvad-yantra* (No. 5 in the list). Now it is labelled as *Nadivalaya-yantra.* A larger specimen can be seen in the Jaipur Observatory. From Joseph Dalton Hooker, *Himalayan Journals,* p. 68.

ascertaining the distance (in time) of the sun, or of any star from the meridian.

N.B. —The method for finding all these is given in 'The Manamandira Observatory,' by Pandit Bápú Deva Sástrí.

6. PHALAKA-YANTRA (invented by Bháskaráchárya). —An instrument for finding the time after sunrise.

The detailed account of this instrument may be found in the translation of the Siddhánta-siromani, by Lancelot Wilkinson, Esq. ('Bibliotheca Indica,' p. 214.)

7. CHAKRA-YANTRA. An instrument for finding the altitude and zenith distance of the sun, and also the longitude of planets. ('Bibliotheca Indica,' p. 212.)

8. CHÁPA-YANTRA (semi-circle) [&] 9. TURYÍA-YANTRA (a quadrant). Instruments for finding the zenith distance and altitude of the sun.

10. SANKU (Gnomon). From its shadow are ascertained the points of the compass, the place of the observer, including latitude, &c., and time.

The Armillary Sphere represents the following circles:— namely, the Prime Vertical, Meridian, Horizon, Equinoctial, Ecliptic, &c., and by the threads that are fastened within the globe Hindu Astronomers determine the parts of any spherical triangle on the globe.

The detailed account of this sphere may be found in the translation of the Siddhánta-siromani, by Lancelot Wilkinson,

Esq. (*Bibliotheca Indica*, pp. 151-176.)

From the Maharaja were also offered [...] models of the Fort of Ramnagar; an armillary globe illustrating the Hindoo system of astronomy; [...] a model of the great Observatory of Benares in silver and sissoo-wood, with an English description of the various instruments by the 'Astronomer Royal' of the College, in other words, the astronomical pundit; a clock, made in the Maharaja's house by an artisan in his employ, showing the signs of the Zodiac, phases of the moon, dates of the month, days of the week, hours, and minutes; a model of a larger clock of the same kind in the inner Court of the Ramnagar Fort; a translation of the Queen's 'Life in the Highlands' into Hindee, each page illuminated, bound in marble and gold, with a diamond in each corner, the Royal Arms on one side and those of the Maharaja on the other, printed at Benares, and illuminated in the fort by an artist in the service of the Maharaja, the marble executed at Agra from designs by the Maharaja, the whole enclosed in a velvet case.'

These astronomical instruments can be divided into three broad categories.

1. Scale models of the masonry astronomical instruments, the originals of which are to be found in the 'Hindu Observatory' at Benares as mentioned in the note. This observatory was one of the five set up by Sawai Jai Singh II, the ruler of Jaipur, in the 1720s at Jaipur, Delhi, Mathura, Ujjain and Benares with diverse kinds of huge instruments in masonry. The Benares Observatory was erected on the roof of a palace on the banks of Ganges. From here one can get a marvellous view of the Ganges. Sir Robert Barker, who was the Commander-in-Chief in Bengal for a short time, visited the observatory and published a description in 1777, together with drawings by Lieutenant-Colonel Campbell.[3] In 1797 William Hunter wrote a comprehensive account of all the five observatories.[4] Since then much has been published on these observatories.[5] The observatory at Mathura does not exist anymore. While those at Delhi and Jaipur are well known, the observatory at Benares remains unknown. Very few people in Benares itself are aware of its existence even today.

Therefore the models of the Benares Observatory presented to the Prince of Wales in 1876 are very valuable. One of these is a model of the complete observatory 'in silver and sissoo-wood, with an English description of the various instruments by the 'Astronomer Royal' of the College.' As will be shown below, this person must be Bapu Deva Sastri (Fig. 7), who was professor of astronomy at the Queen's College Benares and published a short account of the observatory in Sanskrit in 1886. Items 1-5 are models of individual instruments at the Benares Observatory.

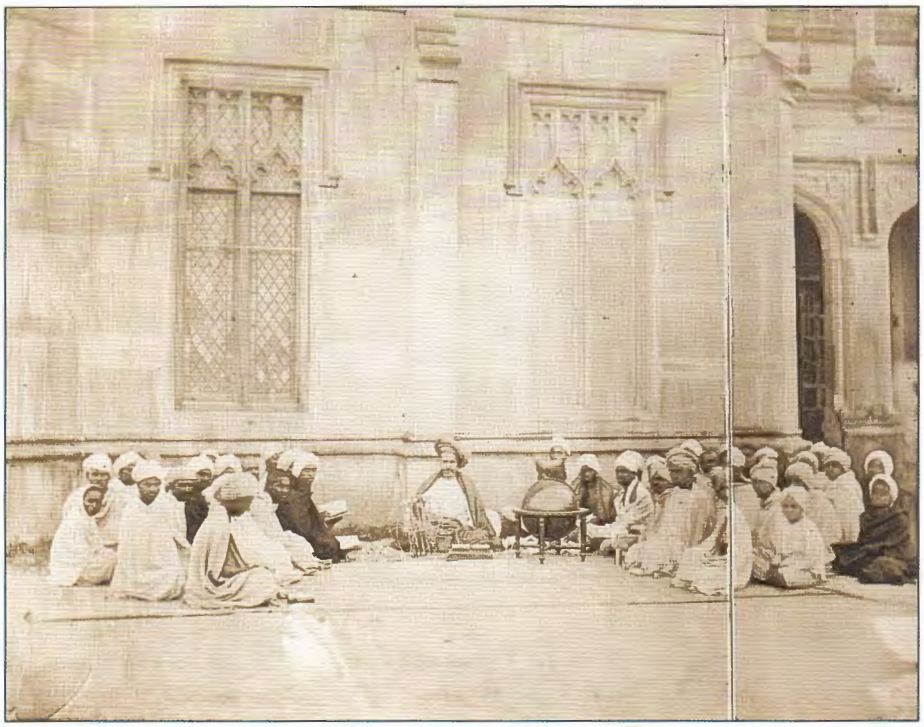

Fig. 7 *Bapu Deva Sastri, with celestial globe, teaching a class at the Queen's College 1870.*

I have seen some nicely made small copper models of the instruments of the Delhi Observatory in the stores of the Science Museum, South Kensington, London, and indifferent models of the Jaipur Instruments at Jaipur. But models of the entire Benares Observatory and/or of the individual instruments there are not to be found in any museum.

2. The second group (items 6-10 and the unnumbered armillary sphere) of instruments were prepared according to the descriptions by the famous Bhaskaracharya (b. 1114) in his astronomical compendium *Siddhanta-siromani* which he composed in 1150. Lancelot Wilkinson (*c.* 1805-1843) of the Bombay Civil Service of the East India Company was a great admirer of this text.[6] He believed that the basic principles of modern astronomy, geometry, trigonometry and the like could be taught to Indians by means of their own *Siddhanta-siromani*. He put his belief into practice by teaching this Sanskrit text at the school established by the East India Company in Sehore in Central India. His best pupil there was Bapu Deva Sastri of whom Wilkinson wrote: 'Indeed he is more fit to be my gooroo (teacher) than my shishya (scholar)'. Sastri later became professor of astronomy at the Queen's College (later renamed Benares Sanskrit College[7]) and rose to be an eminent interpreter of Sanskrit astronomical texts. Wilkinson edited and published the *Siddhanta-siromani* from the Asiatic Society, Calcutta in 1842. His English translation of the second half of the work, which contains the chapter on instruments, was revised and published posthumously by Bapu Deva Sastri as vol. 32 in the *Bibiotheca Indica* Series of the Asiatic Society, Calcutta, in 1861.[8]

While the other instruments were described in earlier Sanskrit astronomical texts, the *Phalaka-yantra* is Bhaskara's own invention. It is a rectangular board measuring 90 x 180 units on which 90 equidistant horizontal parallels are drawn. At the middle of the 30th parallel is inserted a pin to which an index is pivoted. With the pin as the centre, a circle is drawn with a radius of 30 units and the circle is graduated in 360 degrees. This instrument is used for measuring the sun's altitude and then for determining the time graphically. No extant specimens known in any museum collection.

3. The third group consists of a European clock, which shows also various astronomical elements that were of interest to Hindu astronomers and astrologers[9]; it is stated to be 'model of a larger clock of the same kind in the inner Court of the Ramnagar Fort.' The original clock (with a dial measuring

roughly 2 ½ x 2 metres) can still be seen in the museum of the Ramnagar Fort, with a detailed description of its various functions written next to it. It is reproduced verbatim below to give an idea about the smaller version presented to the Prince of Wales:

> 'This unique instrument was constructed in the year 1872 by B. Mulchand, the State clock maker and gives a variety of chronological and astronomical information for which ordinarily a number of scientific instruments would be necessary.
>
> It shows not only correct time of day but also the position of the sun and phases of the moon together with the signs of zodiac and the date of the month and year.
>
> On the right [1] are shown the hours of sunrise, English names of months in Hindi and date, whilst opposite on the left [2] are shown the phases of the moon and the date of Hindu months for each day.
>
> The circle in the centre [3] shows the figures of the Zodiacal Signs over which the sun passes once in a year. From the movement of the black needle which passes over the circle in 24 hours, the ascendant or horoscope and Navamsa can be ascertained. The Navamsa is the ninth part of the Sign of thirty degrees indicated by the lines marked after the signs of the Zodiac to which the needle points. The names of the 12 signs of the Zodiac are shown and these are divided into three parts according to their three different properties, fixed, movable and common.
>
> Below the clock [5] are indicated the day of the week, the forms of the signs of the Zodiac with their names, and Muhurta and planetary hours.
>
> Between the circle and the lower portion of the frame [4] a finger of the index hand and a blue star above it[10] point to the number of hours and minutes already expired and gives the exact time of the day.
>
> The hours are divided by lines into four parts of 15 minutes each whilst simultaneously the hours are shown according to Indian calculation in which twenty-four minutes equal one ghari.
>
> The clock ticks out the seconds, and strikes the hours, half hours and quarters. It requires winding once in eight days. It is correctly calculated and regulated according to latitude, longitude and height of the Benares city above mean sea level.
>
> After a long period of disuse it was eventually completely overhauled, repaired and regulated by B. Munnilal, artist of Ramnagar, under whose supervision and care it remained since 1923.'

One would have thought that 'gold brocade and the famous *Kinkab* of Benares' or 'a translation of the Queen's 'Life in the Highlands' into Hindee, each page illuminated, bound in marble and gold, with a diamond in each corner,' were the most appropriate gifts from the Maharaja to the Prince, but the reason for this unusual gift of astronomical instruments is not clear. Was the Prince known to be interested in astronomy or astronomical instruments? From the references in the list to Wilkinson's translation of the *Siddhanta-siromani* and to Bapu Deva Sastri's book on the Observatory, it is certain that this list of instruments, with their Sanskrit names and functions, was prepared by no other person than Bapu Deva Sastri himself. Did he suggest this unusual gift?

Be that as it may, in connection with my survey of the pre-modern Indian astronomical instruments which are extant today[11], I have visited all the museums in Britain, but did not find any of these items presented to the Prince in any public collection; nor are they mentioned in the eminently useful compilation, *Science Preserved: A Directory of Scientific Instruments preserved in collections in the United Kingdom and Eire* by Mary Holbrook, R. G. W. Anderson and D. J. Bryden. Probably they are still in some private royal collection. For the history of scientific instruments in India, it is important that this collection is located and published.

Notes and References

1. William Howard Russel, *The Prince of Wales' tour: a diary in India; with some account of the visits of His Royal Highness to the courts of Greece, Egypt, Spain, and Portugal,* with illustrations by Sydney F. Hall, M.A., Artist in the Suite of H.R.H. The Prince of Wales, second edition (London: Sampson Low, Marston, Searle & Rivington, 1877), see https://archive.org/details/princeofwalestou00russuoft), pp. 389-91; 616-17. It is a pleasure to appreciate and thank my friend Dr Vijay V. Bedekar who drew attention to the list of instruments in this work.

2. Kinkob or Kincob is special type of gold brocade woven in Benares. For a description and image, visit http://www.vam.ac.uk/users/node/15650.

3. Robert Barker, 'An Account of the Bramin's Observatory at Benares', *Phil. Trans. R. Soc.,* **67** (1777), pp. 598-607. This was supplemented by John Lloyd Williams, 'Further particulars respecting the Observatory at Benares', *Phil. Trans. R. Soc.,* **88** (1793), pp. 45-49. Sir Joseph Dalton Hooker published very fine drawings of three of the instruments in this observatory in *Himalayan Journals, or, Notes of a Naturalist* (London 1854, pp. 74-77. These are reproduced in this article as Figs 4-6.

4. William Hunter, 'Some Account of the Astronomical Labours of Jayasinha, Rajah Ambere, or Jayanagar, *Asiatick Researches,* **5** (1797), pp. 177-211, 423.

5. In the last century there appeared a plethora of writings on these observatories; notable among them are G. R. Kaye, *The Astronomical Observatories of Jai Singh,* Archaeological Survey of India (Calcutta, 1918); Virendra Nath Sharma, *Sawai Jai Singh and his Observatory* (Delhi, 1995).

6. S. R. Sarma, 'Sanskrit as Vehicle for Modern Science: Lancelot Wilkinson's Efforts in the 1830s', *Studies in History of Medicine and Science,* **14** (1995-96), pp. 189-199.

7. It is now a full-fledged Sanskrit University with a splendid collection of Sanskrit manuscripts. There are also some historically important astronomical instruments; cf. S. R. Sarma, 'Katapayadi Notation on a Sanskrit Astrolabe', *Indian Journal of History of Science,* **34** (1999), pp. 273-287; 'A Bilingual Astrolabe from the Court of Jahangir,' *Indian Historical Review,* **38**-1 (June 2011), pp. 77-117.

8. *Translation of the Surya Siddhanta by Pandit Bapu Deva Sastri and of the Siddhanta Siromani of the late Lancelot Wilkinson, Esq., C. S., revised by Pandit Bapu Deva Sastri, from the Sanskrit,* Bibliotheca Indica, 32, Asiatic Society (Calcutta, 1861).

9. When the European pendulum clocks were introduced into India, there was a demand to modify them to suit the local requirements. A survey of such clocks has yet to be made. In the Sanskrit University of Benares, there is a pendulum clock which shows, in addition to the hours and minutes, the traditional Indian units *ghari* (24 minutes) and *pal* (24 seconds). It was apparently produced in Britain. On the dial is written 'Synchronome'.

10. The index hand and the blue star were missing when I saw it on 27.01.1999.

11. I have located some 450 specimens in museums and private collections in India, Europe and North America. A descriptive catalogue of these is under preparation. The details can be seen in my website WWW.SRSarma.in.

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