

Astronomy in British India: Science in the service of the State

R. K. Kochhar

The arrival of the first British ship in India coincided with the invention of the telescope in Europe. There were huge profits to be made from trade with the East Indies provided the ships could be navigated safely. To survive on the featureless ocean, a mariner must know his longitude and latitude and for this he needed astronomical instruments, clocks and star charts. Astronomical observatories were set up at Paris (1667) and Greenwich (1675) to solve the problem of the longitude, and many young men seeking employment with the East India Company took private tuition from the Astronomer Royal.

The earliest modern astronomers in India were the European traders¹ and the Jesuit priests². But these seventeenth century telescopic swallows did not make an Indian astronomical summer. Modern astronomy was not yet needed.

Positional astronomy

With the post-Aurangzeb collapse of the Mughal empire, the European *vaishya* outfits developed *kshatriya* ambitions and got down to the task of acquainting themselves with their future empire. In the early years, the young officers of the British East India Company, feeling and acting like pioneers in an exotic land, took astronomical observations for their own amusement. Surveying instruments were in great demand. They were purchased in England or from the captains and crew of the European ships. When an officer died or left the country, his instruments were readily bought by others or even by the Company itself, which in the course of time came to build a good stock of surveying instruments. The 1757 battle of Plassey transformed the British East India Company into a zamindar, and revenue and geographical survey of its lands began in right earnest.

Apart from utility, astronomy has another aspect, that is, *noblesse oblige*.

Fortunately, at about the same time there occurred an astronomical event that caused world-wide activity. It had already been predicted by Halley that transits of Venus would occur in 1761 and 1769, which could be used to determine the distance to the Sun. For the 1769 event, teams were sent to far-off places, including one led by Captain Cook, who neatly hid his terrestrial ambitions beneath the cosmic pursuits.

The rivalry between England and France involved the transit also³. The secretary of the Royal Society of London wrote on 22 January 1768 to the East India Company on 'an affair of some importance to the Advancement of Science and the honor of this Country. . . . The honor of this Nation seems particularly concerned in not yielding the palm to their Neighbours, and the Royal Society intends to exert all its strength and influence in order to have the observation made with the great accuracy. . . .' The French and English palms were left high and dry at Madras and Pondicherry, because of clouds, but Calcutta did provide some data.

The British Bengal of the late eighteenth century was content with its traditional surveying. A proposal for an astronomical observatory at Calcutta was rudely turned down in 1789, no doubt due to the influence of James Rennell. General William Roy, the founder of the Trigonometrical Survey of Britain, wrote how desirable it was to determine the length of a degree of latitude on the Coromandel coast and in Bengal. The two noted geographers Rennell and Dalrymple made a joint reply² (in 1787): 'Whatever Advantage to Science may be derived from the exact determination of the figure of the Earth, we conceive no other benefit can possibly attend the Admeasurement in Bengal; but that proposed on the Coast of Coromandel will contribute towards the construction of an exact chart of the Coast.'

Unlike Calcutta, Madras was amenable to astronomy because of the hostility of the Coromandel coast^{1,2}. By the 1780s the Company was already a big landlord on the east coast. As the sea traffic increased, the limitations of the Coromandel came into sharp focus. It is rocky and full of shoals, and was without any safe landing for the Indiamen, which were often wrecked. A survey of the coast was thus literally a matter of life and death, and eventually, in 1785, a trained, scientifically equipped surveyor-astronomer Michael Topping (1747-96) was brought from England, passage paid.



Pendulum clock by John Shelton. Identical to the clock used by Captain Cook in his famed transit of Venus voyage, it belonged to William Petrie whose 1786 private observatory became the nucleus of the Company's Observatory. This clock is now at Kodaikanal Observatory and still in use [R. K. Kochhar, *Antiquarian Horology* 17, 1987, 181]

Greenwich had started as an observatory without instruments. Madras Presidency had instruments but no observatory. Topping's work now required a reference meridian, and so the Company set up an observatory at Madras in 1790. It was the first modern public observatory outside Europe; and to use today's term, the first modern research institute in India. While pleading for it, Topping reminded the Company directors that they now had a chance 'of thus affording their support to a science to which they are indebted for the sovereignty of a rich and extensive empire'.

Although the Company had grandiosely declared that the purpose of the Madras Observatory was to 'promote the knowledge of Astronomy, Geography and Navigation in India', there were at the moment more important things than science; for example, increasing the company's revenue by improving irrigation facilities. Topping was given this additional task.

There was a strict ban on any local man, or a half-caste, being involved in survey work lest the information fall into wrong hands. (It is only later, when the British grip on the country was total and unassailable, that Indians were employed in the Survey.) A surveying school was opened at Madras Observatory to train teenaged (European) boys from the military orphanage for appointment as practical surveyors.

The value of various services can be gauged by the price placed on them². Topping received 192 pagodas a month as the Company's Astronomer and Geographical Marine Surveyor (1 pagoda = Rs 3½, £1 = Rs 8). His salary as Superintendent of Tank Repairs and Water Courses was double this: 400 pagodas. He received an additional 100 pagodas as Superintendent of the Surveying School.

The Company made optimum use of the available manpower². Topping's paper on astronomical survey is followed by an account on the cultivation of pepper. During the 1790 war against Tipu Sultan of Mysore, Topping was engaged in making gun carriages. His successor John Goldingham (later FRS) also acted as the chief engineer for a two-year period, earning a (legitimate) commission of the substantial sum of 22,507 pagodas. Goldingham built a banqueting hall (now Rajaji Hall) at Madras to commemorate victory over



A portrait² of Michael Topping (1747–96), the first Madras Astronomer. He held various other posts also.

Tipu, and repaired buildings at Vellore for Tipu's family to be put up in. The East India Company was a commercial concern with profit as its motto. The Governor-General, while ordering the appropriation of 'the Sultan's garden at Bangalore' (the Lal Bagh), clearly instructed², 'A decided superiority must be given to useful plants over those which are merely recommended by their rarity or their beauty.'

The Great Survey

The fall of Tipu Sultan in 1799 brought the whole of South India under the Company's control, with its territories now extending from the east coast to the west. A trigonometrical survey of peninsular India was immediately ordered (1800) on the lines of the recently started French and British surveys. Just as Plassey produced its Rennell, Seringapatam (Srirangapattana) produced its Lambton. The story of the Survey of India is also the story of the British entrenchment in India. Indeed, in 1818 the survey was extended to cover the whole country (and beyond) under the name the Great Trigonometrical Survey of India (GTS). This name is often retroactively applied.

Major William Lambton started his

survey in 1802 from Madras Observatory, using second-hand instruments bought in Calcutta. In the early years, both the Survey and the observatory were engaged in similar work. Till 1810, the Madras Astronomer was even codesignated Surveyor. The observatory provided the reference meridian for the survey work, and Capt. John Warren's 1807 value for its longitude continued to be used in the maps till its revision in 1905. Both the observatory and the Survey were short of instruments and borrowed from each other. The observatory provided time signals for the ships, and repaired private as well as public scientific instruments.

Lambton's death left the Survey the same as Flamsteed's had left Greenwich: without instruments. In 1823 George Everest arranged for the transfer of an instrument from Madras. With characteristic thoroughness, Everest wrote to the Astronomer and to the Surveyor-General, and then personally requested the Resident at Madras to contact the Madras Governor. The instrument was an old, second-hand 18-inch-diameter circular instrument 'which combined the advantage of the Theodolite and Zenith Sector'. Twin of the instrument Lambton had been using, it was not suitable for primary triangulation, but was the best available.

The GTS came into its own when Everest became the Surveyor-General, in addition to being Superintendent of the GTS (1830). The Trigonometrical Survey took priority over all other surveys, and was equipped with the best of manpower and instruments. A workshop was set up (at Calcutta) for repair and reconstruction of instruments. Later a testing facility was established in England for designing new instruments and getting them made.

From its very inception, the Trigonometrical Survey had been manned by military officers. They were however not permitted to be wasted on pure astronomy, although magnetic observations were considered legitimate military business⁴. Where pure astronomy stood *ris-a-ris* applied astronomy is tellingly brought out by the following little known incident. In 1834, on orders from the Government, astronomical instruments from the Survey of India were issued to enable the former Bombay Astronomer to observe the opposition of Mars. This happened when Everest

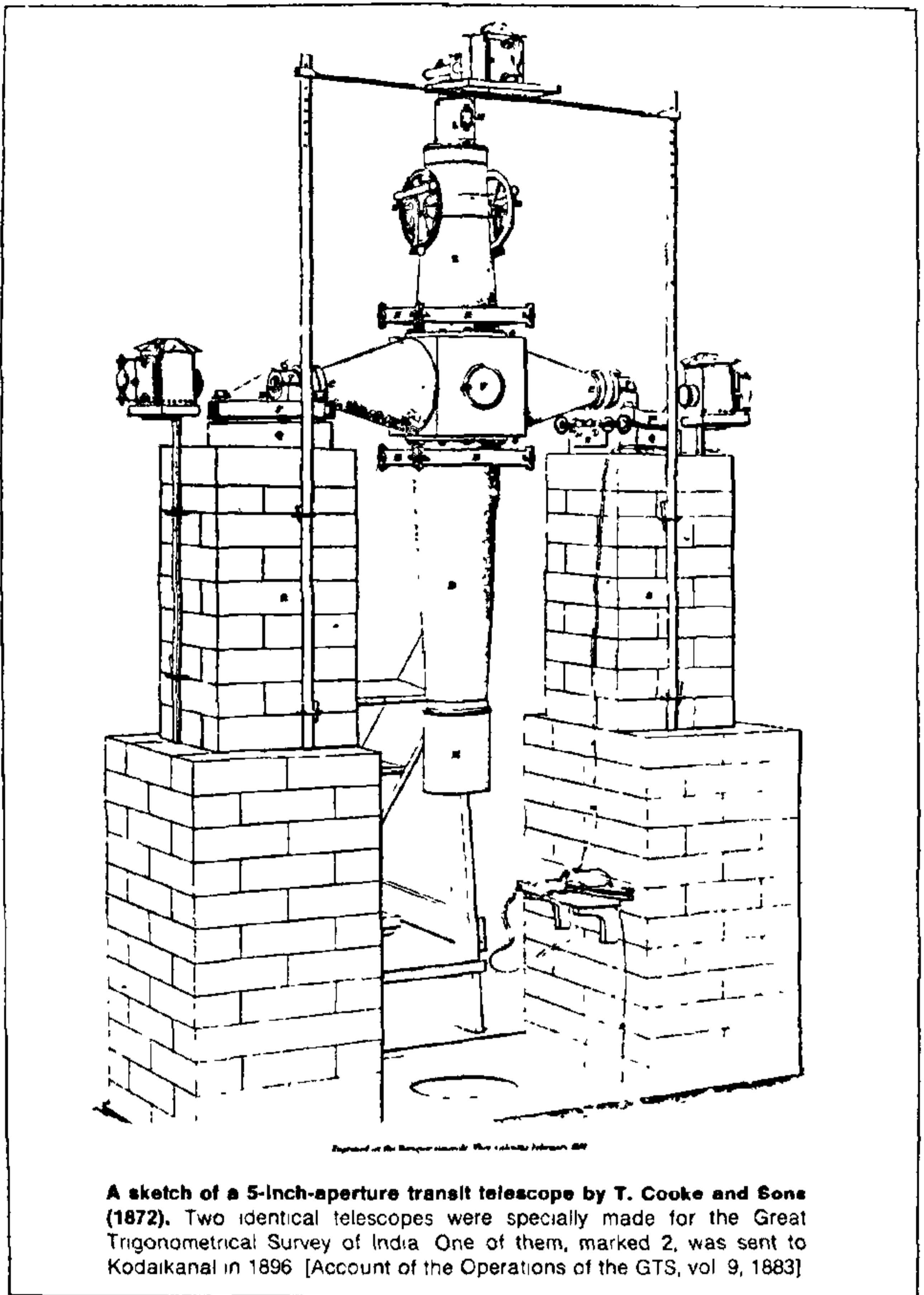
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was out on field work. On his return Everest made a strong protest against the loan, saying², '... The discoveries which the late astronomer of Bombay is likely to make in science would hardly repay the inconvenience occasioned by retarding the operations of the Great Trigonometrical Survey. ...'

The relative importance of the two streams of astronomy, applied and pure, is best brought out by economics. In 1801 Lambton's monthly salary was fixed at Rs 980, when the Madras Astronomer was drawing Rs 672. Seven decades later, by 1877, the GTS chief's salary had gone up to Rs 2565, whereas the Madras Astronomer's had crawled up to a paltry Rs 800. Fifteen surveyors were drawing more than the Astronomer, three of them Fellows of the Royal Society⁵.

With the reorganization of the GTS in 1830, Madras Observatory became irrelevant as far as geography was concerned, but still had a role to perform as a navigational aid. Increasing sea traffic required familiarity with the southern skies. In 1829 the observatory acquired for the first and the last time state-of-the-art instruments. Using these 4-inch-aperture telescopes. Thomas Glanville Taylor (former Assistant at Greenwich Observatory, and later FRS) produced in 1844, after 14 years of painstaking labour, the celebrated Madras Catalogue, which gives positions of about 11,000 southern stars. It was hailed by Sir George Biddell Airy, the Astronomer Royal, as the greatest catalogue of modern times'. (The Catalogue was revised in 1893 by the Nautical Almanac with financial assistance from the India Office and the Royal Society of London¹.)

Madras Observatory was now entirely redundant as far as utilitarian astronomy was concerned. And when observatories were set up in South Africa and Australia, even the British astronomers lost interest. Those were the days when the sun never set on the Empire; and wherever it did, the Astronomer Royal took over. In 1866 the Secretary of State for India wrote to the Madras Governor¹: 'From the information with which Professor Airy has furnished me, I have come to the conclusion that it is not necessary, in the interests of science, to maintain permanently in India any observatory for the purpose of general astronomical investigation. In his opin-



A sketch of a 5-inch-aperture transit telescope by T. Cooke and Sons (1872). Two identical telescopes were specially made for the Great Trigonometrical Survey of India. One of them, marked 2, was sent to Kodaikanal in 1896 [Account of the Operations of the GTS, vol 9, 1883]

ion, systematic observations may be more advantageously taken at other observatories in the Northern and Southern Hemispheres.' The Secretary of State suggested (on the advice of the Astronomer Royal) that Madras Observatory be closed down, that astronomical activity at Bombay be restricted to the determination of local time, and that the Bombay Astronomer report to the Astronomer Royal.

This threat to Madras Observatory from back home was squarely met by the local British pride, with the Director of Public Instruction spiritedly writing to the Chief Secretary, Madras^{1,3}: 'I earnestly hope that the Rulers of India

will take a higher and more extended view of the matter, and consider what is due to this country. . . I earnestly hope. . . that India should have at least one well-equipped and well-officered Astronomical Observatory, and that the Astronomer. . . should be left in independence and not made a subordinate of another Astronomer.'

The observatory did survive but barely. The 30-year uninterrupted tenure (1861–91) of Norman Robert Pogson is tragic testimony to the wasted opportunities at Madras. Pogson came with a solid reputation. Attracted no doubt by good salary, he hoped to make full use of his unquestioned access to the

southern skies. He had set his heart on a thorough southern-sky survey and on working on his first love, the variable stars. He was prevented from both and forced to carry on drab, routine, irrelevant observations of transits year after year, which he most obstinately refused to reduce and publish. No new instruments were sanctioned during Pogson's stewardship. What revived India's astronomical fortunes was the advent of the new field of solar physics, or physical astronomy as it was then called.

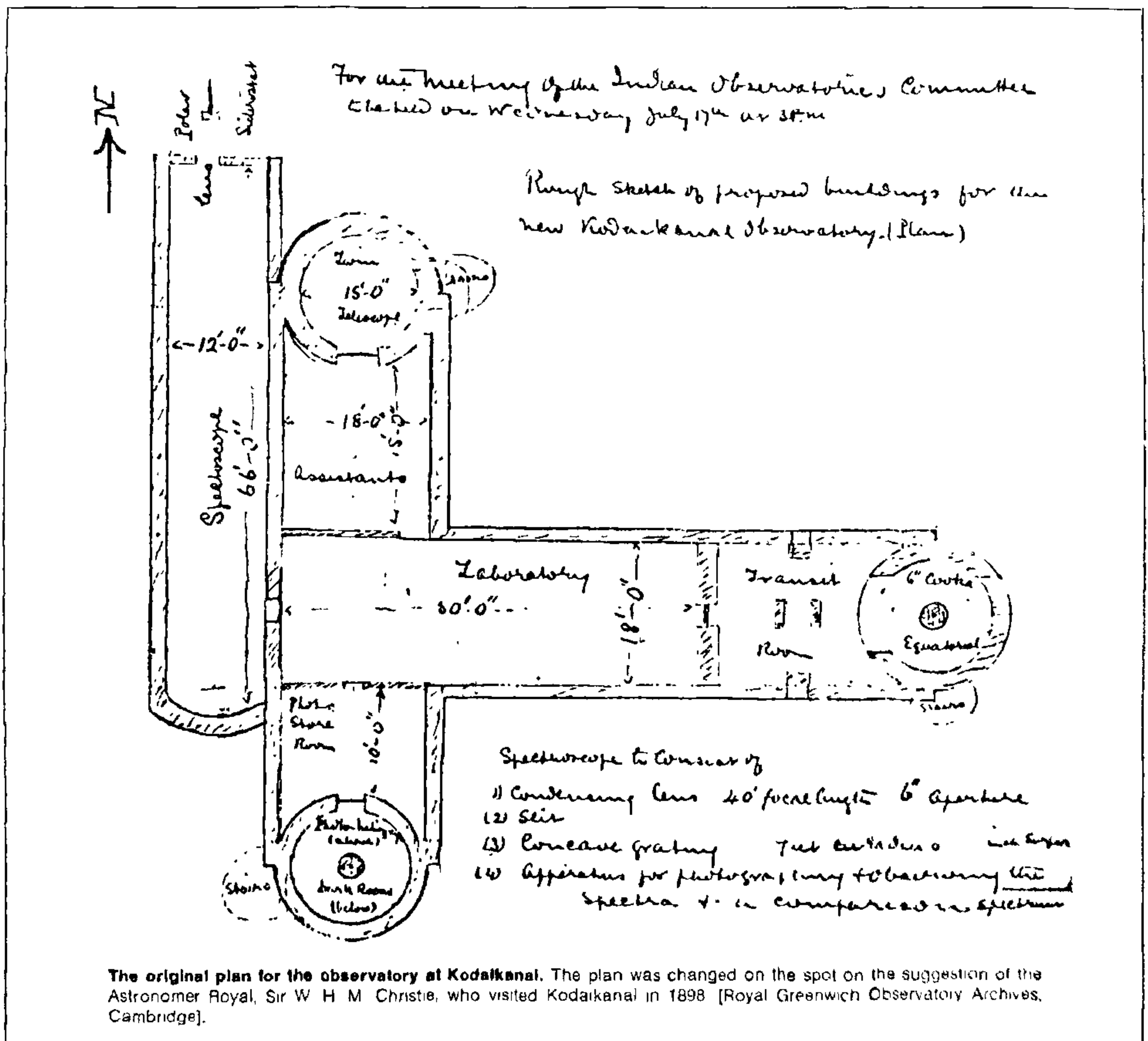
Solar physics

In the second half of the nineteenth

century it became possible to study the physics of the Sun (and stars), in contrast to the earlier studies of merely the position of celestial bodies. Solar physics did not come to India because the British interests needed it. It came because the British scientists required data on the Sun, which they could not collect at home, but which their sunshine-rich colony could provide.

What the twin transits of Venus of 1761 and 1769 had done for positional astronomy was now accomplished for solar physics by the transits of 1874 and 1882. Equipment was sent out from England for observing the 1874 transit under the auspices of the Survey of

India. Tennant's suggestion for using the equipment to start a solar observatory at Simla was turned down, but success attended the British solar physicist Joseph Norman Lockyer's efforts. Lockyer used his good offices with Lord Salisbury, the Secretary of State for India, who had visited Lockyer's observatory a number of times and shown great interest in his work. Salisbury wrote¹ to the Governor-General of India on 28 September 1877, "... and viewing the fact that a study of the condition of the sun's disc in relation to terrestrial phenomena has become an important part of physical investigation, I have thought it desirable to assent



to ... obtain photographs of the sun's disc by aid of the instrument in India'

Daily solar photography started at the Survey of India, Dehra Dun, in 1878 and continued till 1925, the photographs being sent to England. In the meantime an observatory was set up at Kodaikanal in 1899 for solar studies. Not surprisingly, it was also justified on utilitarian grounds. It was said that the observatory would help understand the occurrence of famines. The argument was topical because Madras Presidency had been hit by a severe famine in the 1870s. However, the scientific programme for the Kodaikanal Observatory prepared by the Royal Society in 1901 makes no mention of solar-terrestrial connection⁶!

Kodaikanal was in the forefront of solar research under John Evershed, who was at the observatory from 1907 to 1922. Evershed had offers from the United States, but he decided to come to India, no doubt to work in solitary splendour. Equipping the observatory with state-of-the-art instruments, some of which he himself made, he discovered the Evershed effect (1909).

Critique

We have seen that modern science landed in India pretty early. But if one goes by Indian published sources alone, one can never get an inkling of the momentous changes that were taking place in Europe on industrial and scientific fronts. This is not surprising. All intellectual activity sponsored by the British in India was dictated by the country's cultural and geographical novelty. Modern science in India was a utility; its function was to help the British manage their colony in a profitable and efficient manner. Any benefit to science itself was unintended and secondary.

Science in British India was a tool, maintained by the commercial and geopolitical interests. When Lambton damaged his theodolite, he had the military workshop and its artificers to help him. Madras Observatory' could survive with its old instruments, thanks to the existence of a workshop belonging to the Public Works Department. (The workshop was asked to earn its way through.) The British Empire had an instrument department to look after its scientific requirements⁷.

When the Indian princes tried to imitate the British in pursuit of science they failed. They had no need of science to begin with, nor the institutions to support it. The Nawab of Avadh set up an observatory at Lucknow (in 1831), which, as befitted a Nawab, was equipped with the best instruments money could buy. The support was princely, but the scientific control was British. One of the charges levelled against the observatory was that 'the Europeans and not Indians are benefitted'. The observatory closed down when the instruments and the novelty wore off. A similar fate awaited astronomy at Trivandrum (1837), but this observatory still had a scientific role to play. Being close to the magnetic equator, it was suitable for collecting magnetic data^{1, 3}.

The role assigned to the Indians was of providing cheap labour, which they did admirably. Babu Radhanath Sickdhar (his spelling) earned a name for himself as an able computer, while Syed Mir Mohsin Husain from Arcot, who did not know English, rose to head the Mathematical Instrument Department at Calcutta, a post held before and later by Europeans.

While these people earned their laurels in spite of their ethnicity, there were others who shone because of it. Indian surveyors were sent out to the trans-Himalayan regions, where the Europeans themselves would have been easily spotted and killed. With characteristic British thoroughness and disdain, these surreptitious surveyors were only taught how to take the observations; they were not told how to reduce their data lest they cheated. When they were exceptionally useful, they were honoured with scientific gold medals, *jagirs*, and titles; otherwise even their names are not recorded. Two well-known names are Nain Singh and Kishan Singh. They were called Pandit brothers. They were neither Pandits in the sense of a caste appellation, nor were they brothers; they were cousins.

The British could not have ruled over a far-away subcontinent without help from science and the 'natives' themselves. This brought Indians into contact with modern science. At least in the case of astronomy, modern science did not supplant anything worthwhile, as is illustrated by the case of two nineteenth century astronomers.

Chintamani Ragoonatha Charry^{8, 9}

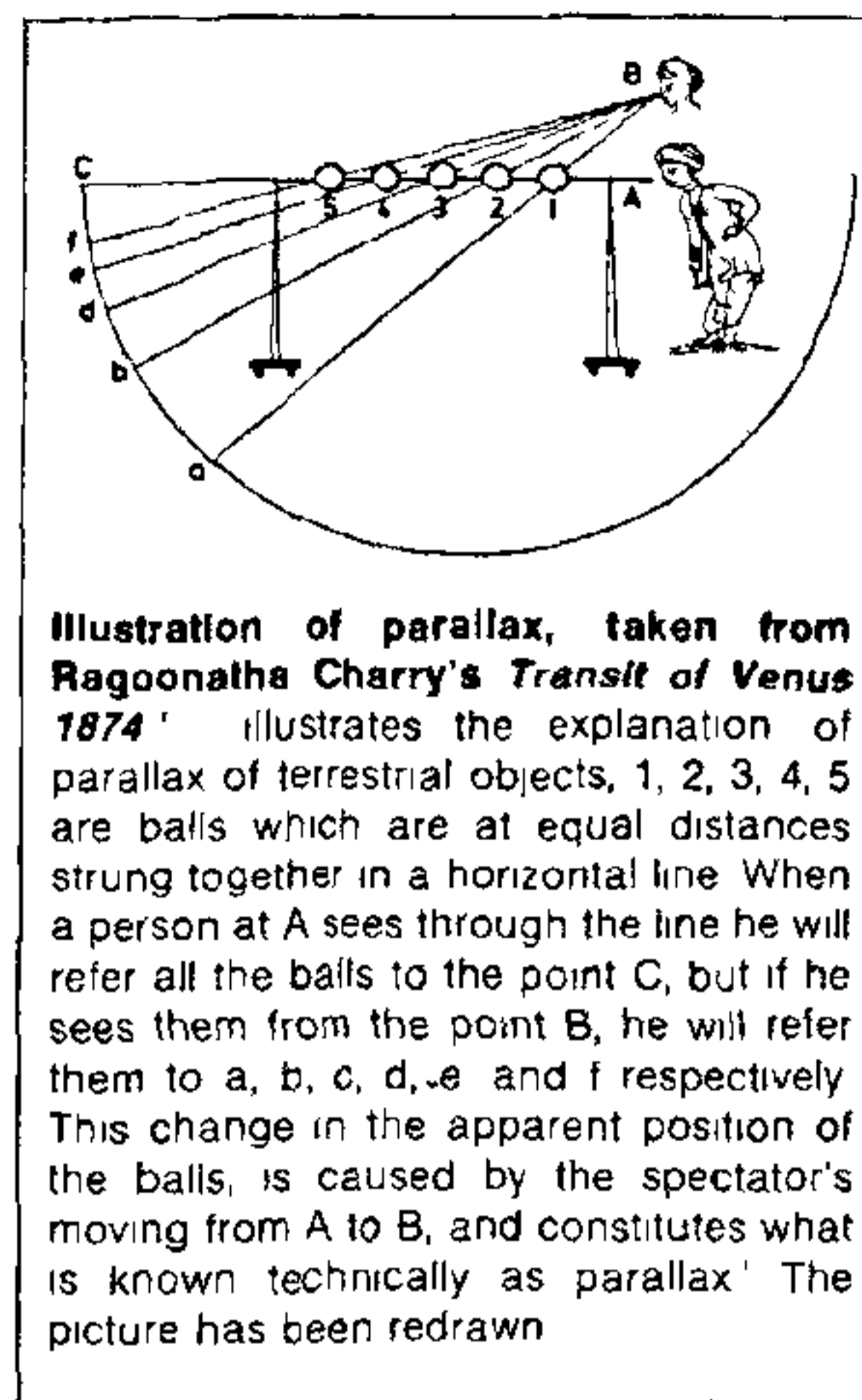


Illustration of parallax, taken from Ragoonatha Charry's *Transit of Venus 1874*. It illustrates the explanation of parallax of terrestrial objects, 1, 2, 3, 4, 5 are balls which are at equal distances strung together in a horizontal line. When a person at A sees through the line he will refer all the balls to the point C, but if he sees them from the point B, he will refer them to a, b, c, d, e and f respectively. This change in the apparent position of the balls, is caused by the spectator's moving from A to B, and constitutes what is known technically as parallax. The picture has been redrawn.

(1828–80) was the son of an Assistant at Madras Observatory. He joined the observatory as a daily wager when still a teenager and rose to become First Assistant. His 1867 discovery of a variable star, R Reticuli, is the first recorded astronomical discovery by an Indian. He compiled a work in Tamil entitled *Jyotisha Chintamani*⁸. (He did not know Sanskrit.) He also published an almanac, *Drig-ganita Panchanga*, with the help of the Nautical Almanac. Ragoonatha Charry gave public lectures on astronomy and brought out a book on the 1874 transit of Venus. This book explains the phenomenon through a dialogue between a Pandit and a Siddhanti (an astronomer). Originally written in Tamil, it was translated into English and other, local languages (including Urdu)¹⁰.

In sharp contrast is the case of Samant Chandrasekhar¹¹, who was born in 1835 in the small village of Khandpara, some 50 to 60 miles west of Cuttack. Following in the footsteps of Bhaskara (b. 1114 AD) and using traditional instruments, he completed, at the age of 30, his *Siddhanta Darpana*, which contains 2500 *shlokas* of various metres, including 2284 composed by him. In his later years he did see through a telescope, and bitterly regretted that he had not had the advantage of such an instrument in his younger days.

As a tailpiece it may be mentioned

that the noted Indian scientist Meghnad Saha, whose work led to the founding of theoretical astrophysics, was offered the Deputy Director's post at Kodaikanal by the Calcutta-based Director-General of Observatories. For some reason never really explained, Saha turned down the offer¹².

1. Kochhar, R. K., *Vistas in Astronomy*, 1991, (in press)
2. Phillimore, R. H., *Historical Records of the Survey of India*, 5 vols., Dehra Dun, 1945-58. This is the most authentic reference on the Survey of India.
3. Love, H. D., *Vestiges of Old Madras*, 4 vols., John Murray, London, 1913.
4. Letter from Maj J. F. Tennant to the Chief Secretary, Fort St George, 11 January 1860. Proc. Madras Govt, Publ. Dept. Tennant was the Astronomer for a year (1859-60), but had to return to military service. He rose to become a lieutenant-general and President of the Royal Astronomical Society.
5. Markham, C. R., *A Memoir on the Indian Surveys*, 2nd edn, W. H. Allen & Co., London, 1878.

6. Annual Report of Kodaikanal Observatory, 1901.
7. 'The number of instruments issued in the year 1887-88 was 57,293, valued at Rs 2,25,599, while out of the total stock 7,387, valued at Rs 1,16,246, were procured from England, 31,846, valued at Rs 35,252, were purchased in the local market, and 17,960, valued at Rs 33,320, were manufactured in the Mathematical Instrument workshop. The last number shows a large increase, nearly 100 per cent, over the figures of the previous year, and the value has risen by nearly Rs 10,000.' See Black, C. E. D., *A Memoir on the Indian Surveys 1875-1890*, E. A. Arnold, London, 1891.
8. Dikshit, S. B., *Bhartiya Jyotish Sastra*, (Engl. transl), Part 2, India Meteorological Department, 1981, Dikshit Sanskritizes the name to Raghunatha Acharya. Also see *Madras Mail*, 7 February 1880.
9. Pogson, N. R. wrote to the Chief Secretary on 27 December 1877 about Ragoonatha Charry: 'Formerly the best man in the place; so able, willing, and deserving. . . Grievously deteriorated of late years in health, energy, and scientific usefulness; . . . merely allowed to hang on

to qualify for maximum pension, to make up the years he served as a supernumerary under the required age. [His salary was Rs 150 p.m.]. Govt. of Madras, Publ. Dept, 10 March 1881.

10. Ragoonathacharry, C., *Transit of Venus 1874* (available at Royal Greenwich Observatory, Cambridge).
11. Roy, Joges Chandra (ed.), *Siddhanta Darpana, A Treatise on Astronomy by Mahamahopadhyaya Samant Sri Chandrasekhara Simha*, Indian Depository, Calcutta, 1897.
12. Sen, S. N., (ed.), *Professor Meghnad Saha—His Life, Work, and Philosophy*, Meghnad 60th Birthday Committee, Calcutta 1954. This is Saha's authorized biography.

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Saha's proposals for upper-atmospheric studies

S. N. Ghosh

Meghnad Saha was the first to propose the setting up of an upper-air observatory for the study of the characteristic features of solar spectrum in the far- and extreme-ultraviolet regions and their control of upper-atmospheric phenomena.

In a paper, 'On a solar stratospheric observatory', published in 1937 in the bulletin of astrophysical records of Harvard University's observatory¹, Saha visualized the enormous scientific information that could be obtained from such an observatory. 'The observed solar spectrum photographed from altitude above 40 km', he said, 'would then extend deep into the ultraviolet.' This idea is dealt with in detail in two other publications^{2,3} and in Saha's presidential address at the Indian National Institute of Sciences meeting at Lahore in 1938. In these papers, Saha observed: (i) A satisfactory theory of upper-air phenomena must be based on precise knowledge of the action of ultraviolet sunlight below 3000 Å (300 nm) on O₂

and N₂. Apart from observations from space, well-planned laboratory experiments on the spectra of these absorbing molecules are essential.

(ii) The ultraviolet radiation from the Sun differs widely from that of a black body and in selected wavelength regions the Sun must be emitting nearly a million times more photons than are given out by a black body at 6500 K.

(iii) The ultraviolet spectrum of the Sun consists of a continuous spectrum with superimposed emission lines of H, He, He⁺, Fe⁺ ions, etc.

Saha made these remarks at a time when ground-based instruments could record the solar spectrum only up to 2900 Å. To prove his predictions, there was a need to carry observing instru-

ments above the Earth's absorbing layer⁴. Unfortunately, during Saha's lifetime, balloons carrying recording instruments could reach only low heights and rocket-borne experiments had only just begun. It was then extremely difficult to know the characteristics of sunlight in the deep-ultraviolet region, and consequently their control of upper-atmospheric phenomena remained unexplored.

Upper-atmospheric studies

Immediately after World War II the study of the upper atmosphere by direct methods was greatly enhanced. Balloons, which could carry recording instruments