K.D. Naegamvālā: The Founder of the First Astrophysical Observatory in India

S. M. Razaullah Ansari

Abstract Kavāsjī Dādābhāi Naegamvālā was born in 1857, and belonged to an illustrious family of Parsi contractors. He was educated at Elphinstone College in Bombay, where he studied for B.A. and M.A. before being appointed a Lecturer at the College in 1882. Six years later he shifted to the College of Science in Poona, as their founding Professor of Astrophysics, and in 1900 became the Director of the new Takhtasinghji Observatory in Poona. He remained at the College until his retirement in 1912, and the Observatory was then closed and its astronomical instruments transferred to Kodaikanal Observatory. Naegamvālā died in 1938.

In this paper I relate briefly the tremendous efforts of Naegamvālā to educate himself in 'celestial spectroscopy and astronomical physics', first with the aid of Father Lafont (Calcutta) and later at European observatories in Rome, Potsdam and South Kensington, before he established India's first astrophysical observatory in Poona. For this he procured what, at the time, was the most modern astronomical equipment in India. In his endeavours, Naegamvālā was helped in particular by the Astronomer Royal, Sir William Christie. I then end this paper by examining Naegamvālā's observations of the 1898 total solar eclipse. This paper is based largely on archival records and family papers (I had the privilege to meet Nowrojee in 1976 at Poona, when he was in his mid-80s. I was also fortunate then to meet Professor Naegamvālā's grand-daughter, Dr. Silloo M. Vacha, grandson, Mr. J.-P. Naegamvala, and the mother of Dr. Vacha, who were very kind in letting me study the Family Papers, containing Professor Naegamvālā's publications, hand-written drafts and typescripts. They are referred to here as 'Family Papers'. Records concerning Professor Naegamvālā's work and Takhtasingji Observatory are extant also in the Maharashtra Government Archives (Mumbai) and in the Education Department (1882–1899), which I refer to here simply as 'Bombay Archives' (and then cite the No. and the Year).).

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1 Introduction

The second half of the nineteenth century was a time of rapid development in Indian astronomy, as the Subcontinent accommodated local and international solar eclipse and transit of Venus teams in 1868, 1871, 1874, and 1898, and responded to international developments in astrophysics and especially solar physics (e.g. see Ansari 2000, 2011; Kapoor 2014; Kochhar 1993; Kochhar and Orchiston 2017). This was the era when India saw the establishment of two different astrophysical observatories, one by the Jesuit scientist Father Eugene Lafont at St. Xavier College in Calcutta and the other by K.D. Naegamvālā at the College of Science in Poona.

In this paper we focus on the second of these observatories, and after briefly reviewing Naegamvālā's life we examine the scientific equipment that he assembled at his Takhtasingji Observatory, the research that he carried there, and his observations of the solar chromosphere and corona from Jeur, western India, during the 22 January 1898 total solar eclipse. I regard this meticulously planned expedition as Naegamvālā's most remarkable achievement.

2 A Brief Life Sketch

Kavāsjī Dādābhāī Naegamvālā (1857–1938; Fig. 1) belonged to an illustrious family of Parsi contractors. His grandfather Jamsetjee Dorabjee Naigaumvala (1804–1882) had been a pioneer Contractor of Railways in India, as praised by the Assistant Secretary to Railways in Bombay. K.D. Naegamvālā was educated at Elphinstone College in Bombay, where he obtained a B.A. degree in 1876 and an M.A. in Physics and Chemistry in 1878, in the latter year winning the Chancellor's Gold Medal. In 1882 he was appointed a Lecturer in Experimental Physics at the College.

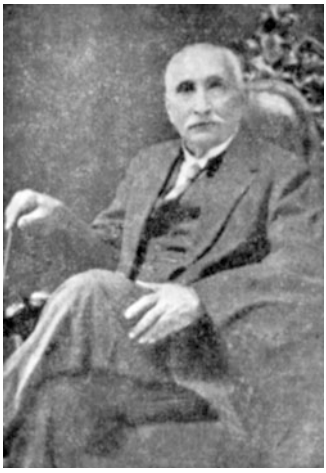


Fig. 1 The photograph of K.D. Naegamvālā on the cover page of the April 1939 issue of the Gujrati English magazine *Hindi Graphic* (Bombay)

Then in 1888 he joined the College of Science in Poona (presently the College of Engineering) as a Professor of Astrophysics, and in 1900 he was appointed Director of Takhtasingji Observatory at the College.

I may mention here that from the 1880s, Naegamvālā was in active correspondence with the British Astronomer Royal, William Christie (1845–1922; Dewhirst 2014); Norman Lockyer (1836–1920; Meadows 1972), the founder of the solar observatory at South Kensington in England; William Huggins (1824–1910; Becker 2011) from Tulse Hill in England; Edward W. Maunder (1851–1928; Baum 2014; Kinder 2008) from the Royal Observatory in England and a one-time Vice-President of the British Astronomical Association; Hermann Carl Vogel (1841–1907; Frost 1908), Director of the Potsdam Astrophysical Observatory in Germany; and the American, George Ellery Hale (1868–1938; Adams 1939). Through these contacts Naegamvālā became known internationally, and he was elected a Fellow of the Royal Astronomical Society in 1885 (see Ansari 1985: 36–40).

In 1912 Naegamvālā took early retirement from the College of Science, and he died in 1938. Subsequently, a detailed biography of him was written by his son Nowrojee K.D. Naigamvalla (1946), and this is listed in full here in the References section of this paper.[1]

3 The Establishment of Takhtasingji Observatory

It is reported that the Maharaja Takhtasingji of Bhavanagar (1858–1896) visited Bombay University in October 1882, when Naegamvālā suggested to him as follows:

> . . . that adequate means for the pursuit of spectroscopic investigation did not exist in any of the Colleges affiliated to the Bombay University and that Elphinstone College would be prepared to organise a spectroscopic laboratory, if provided with a sum sufficient for the purpose. (Bombay Archives, No. 4906, 2 November 1882).

As a result, the Maharaja offered a sum of Rs. 5000 and also hoped for a matching grant by the Bombay Government to establish such a laboratory. His motivation was twofold:

> On one hand I [the Maharaja] have the satisfaction of knowing that I had done something to supply a very desirable means for [the] study of an important branch of science. I shall, on

[1] I had the privilege to meet Nowrojee in 1976 at Poona, when he was in his mid-80s. I was also fortunate then to meet Professor Naegamvālā's grand-daughter, Dr. Silloo M. Vacha, grandson, Mr J.P. Naegamvala, and the mother of Dr. Vacha, who were very kind in letting me study the Family Papers, containing Professor Naegamvālā's publications, hand-written drafts and typescripts. They are referred to here as 'Family Papers'. Records concerning Professor Naegamvālā's work and Takhtasingji Observatory are extant also in the Maharashtra Government Archives (Mumbai) and in the Education Department (1882–1899), which I refer to here simply as 'Bombay Archives' (and then cite the No. and the Year).

> the other hand, have the gratification of thinking that it was permitted me to perpetuate the memory of my present visit . . . (Raja's letter of offer in Bombay Archives, No. 738, 1882).

It is clear that the main spirit behind this establishment of the laboratory was the young lecturer K.D. Naegamvālā, who rightfully claimed, later, that he was responsible for the establishment of Takhtasingji Observatory (Naegamvala 1899). In this context, it is interesting to note that after he founded a spectroscopic laboratory in Bombay, Naegamvālā established an astrophysical observatory in Poona (modern Pune).

4 The Acquisition of Spectroscopic and Astronomical Physics

Obviously Naegamvālā planned to acquire knowledge about astrophysics from spectroscopic laboratories or observatories so that he could use the spectroscopic apparatus. The only spectroscopic laboratory in India at that time was at St. Xavier College Observatory in Calcutta, where the Director, the Jesuit astronomer Father Eugene Lafont (1837–1908; Fig. 2; Biswas 1994, 2003; Udias 2003), was engaged in solar and stellar spectroscopy using 9-in (22.9-cm) and 7-in (17.8-cm) refracting telescopes (Chinnici 1995/96). As Naegamvālā noted, Lafont's work consisted of

> . . . delineation of the forms of the Solar prominences and spots with the object of supplementing . . . similar observations . . . [at] the College Romano . . . (Bombay Archives, Vol.10, No. 244, 1884).

Naegamvālā is referring here to the College Romano in Italy, where Father Angelo Secchi (1818–1878) had been the Director of the Observatory, and had founded the Società degli Spectroscopisti Italiani in 1867. To note here is that Father Lafont had been in close contact with Father Secchi up until his death just 4 years earlier, and that at this time planetary and stellar spectroscopy also were being carried out by William Huggins in England and H.C. Vogel in Germany.

Fig. 2 Father Eugene Lafont (https://en.wikipedia.org)

Through Father Lafont's influence, it was natural that Naegamvālā's interest shifted from a spectroscopic laboratory to an astrophysical observatory. After convincing Principal Wordsworth of Elphinstone College, Naegamvālā used recommendations from Father Lafont and Father Deckmann (Professor of Physics at St. Xavier College) to request funding so that he could visit various observatories and laboratories in Europe (Bombay Archives). This trip was approved.

Naegamvālā received a grant of Rs. 10,000 to purchase equipment, and after visiting Father Lafont's Laboratory in Calcutta he proceeded to Europe. However, Elphinstone College decided to grant him leave without pay, so presumably Naegamvālā was able to use part of the grant for his daily living expenses, but especially meals and local travel. Once in Europe, Naegamvālā visited the College Romano in Rome, the Astrophysical Observatory in Potsdam, the Observatory of Astronomical Physics at Meudon in Paris and Sir Lockyer's Solar Physics Observatory at South Kensington in England, where he trained himself in handling the new spectroscopic and photographic apparatus (Bombay Archives, No. 244 (1884) and No.441 (1886)). After visiting the above mentioned European observatories Naegamvālā felt confident about establishing an astrophysical observatory in India.

5 Equipment for the New Observatory

Naegamvālā compiled a list of suitable instruments, had this approved by the Astronomer Royal, Sir William Christie, and then returned to India.

Initially Naegamvālā worked in his spectroscopic laboratory in Bombay, then he shifted to the College of Science (the present-day College of Engineering) in Poona where he established Takhtasingji Observatory (for these and other localities mentioned in this paper see Fig. 3). He began as a Lecturer in Astronomy and Curator of the Observatory (Draft dated 28 May 1888 in Family Papers, Bombay Archives, No. 1464, Aug. 10, 1888). By the end of 1888 the Observatory was complete (Naegamvala 1888), and Naegamvālā sent Sir William Christie a list of its instruments, which included:

A 20-in (50.8-cm) Grubb reflector
A 6-in (15.2-cm) Cooke equatorial
An 8-in (20.3-cm) achromatic lens, 12-in (30.5-cm) siderostat and solar grating spectroscope
A large stellar spectroscope
A 3-in (7.6-cm) transit instrument
A standard clock.
A chronograph

Naegamvālā was conscious of the excellent quality of this equipment, which at the time was not available elsewhere in India, even at Madras Observatory, and he wrote to the Astronomer Royal:

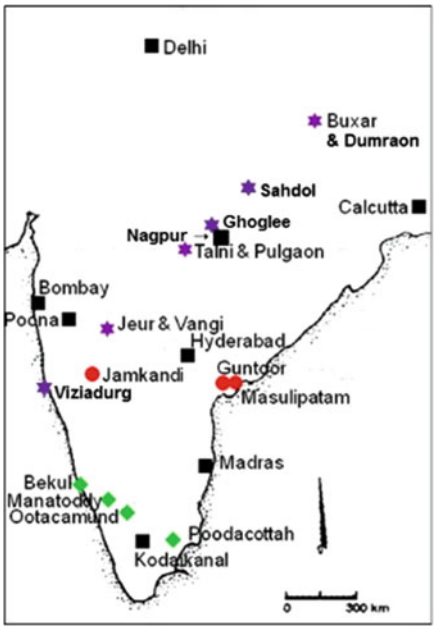


Fig. 3 Map of India showing Bombay, Calcutta, Delhi, Kodaikanal, Madras, Poona, and the principal observing sites used during the total solar eclipses of 1868 (red dots), 1871 (green diamonds) and 1898 (purple stars). Jeur is the most southerly of the 1898 eclipse observing sites, and is located between Poona and Hyderabad (map: Wayne Orchiston)

> My earnest desire is that this splendid equipment that I have managed to bring together should not lie idle and that I may be put in a position to make use of it. (Naegamvala 1896).

In reply, Sir William suggested:

> It is very desirable that the fine equipment of the observatory . . . should be fully utilized as such valuable work might be done with it at a station like Poona near the Equator where observations of the Sun, Moon Planets etc. could be made under much more favourable conditions than in our Northern observatories. India seems to be peculiarly marked out for observations of the Sun, especially spectroscopic . . . (Christie 1897).

Following Christie's advice, Naegamvālā started working in the field of astrophysics and solar physics. This research had culminated in his observations of the total solar eclipse of 22 January 1898.

6 The Astrophysical Work

According to the list of publications available to me, the details of which are given in the References section, Naegamvālā published nine different research papers between 1891 and 1902 (inclusive), following his first publication, in 1888, which merely announced the establishment of Takhtasinghji Observatory in Poona. Thereafter Naegamvālā typically published one paper or short communication per year, mainly in *Monthly Notices of the Royal Astronomical Society*. These ranged from spectroscopic studies of the Orion Nebulae (Naegamvala 1891b), the sunspot group

of February 1892 (Naegamvala 1892), NGC 6595 (Naegamvala 1895), a nebula and 43 Virginis (Naegamvala 1897) and nova 1901 in Perseus (Naegamvala 1901), together with observations of the 9 May 1891 transit of Mercury (Naegamvala 1891a).

7 The Total Solar Eclipse of 1898

However, Naegamvālā's most remarkable research was carried out during the 22 January 1898 total solar eclipse, from Jeur (see Fig. 3) in western India.

India had already made a remarkable contribution to solar physics, through the 1868 total solar eclipse (see observing sites in Fig. 3). This 'watershed event' was the first eclipse to be subjected to detailed spectroscopic analysis, and resulted (eventually) in the identification of a new element, helium (see Nath 2013).

Overseas and local observing teams also congregated in India for the 1871 total solar eclipse (see Fig. 3), when further advances were made in solar physics (see Kochhar and Orchiston 2017).

With the advent of the 22 January 1898 eclipse, India was again host to international research teams, from England (Christie 1898a; Grove-Hills and Newall 1898; Maunder 1899), Japan (Terao and Hirayama 1910), Scotland (Copeland 1898) and the USA (Burckhalter 1898; Campbell 1898, 1900; cf. Orchiston and Pearson 2017), and these positioned themselves at eight different observing sites in central India (see Fig. 3). Apart from Naegamvālā's team, India also supplied another 'local' eclipse team, this time from St. Xavier's College in Calcutta and led by the Jesuit, Father V. de Campigneulles (1899; Udias 2003; cf. de Campigneulles and Josson 1898). In addition, Evershed and Michie-Smith from Kodaikanal Observatory participated in one of the British expeditions (Maunder 1899).

Naegamvālā chose to observe from Jeur, adjacent to the American Lick Observatory compound, and we can cite his own words to highlight the difficulties he faced in planning an expedition in the interior of the Indian countryside at the end of the nineteenth century:

> The country in the vicinity of Jeur was . . . flat, almost devoid of trees except a few scraggy babuls and the supply of water was not plentiful. Plague had also appeared in Karmala, the chief town of the taluka [sub-district], but had not yet spread to the surrounding villages . . . (Naegamvala 1902: 3).

One can understand how difficult it would have been to transport the fine and delicate instruments Naegamvālā employed for his spectroscopic observations. For these he relied on the horizontal photoheliograph shown in Fig. 4.

The sky was cooperative on 22 January 1898, and all of the observing teams located at Jeur successfully observed the eclipse. Naegamvālā then analysed his team's observations and began writing them up. First he prepared a short communication for the *Astrophysical Journal*, on his successful photograph of the 'flash spectrum', which is shown here in Fig. 5. The editor of the *Astrophysical Journal* pointed out to readers that the reproduction ". . . failed to bring out all the fine lines

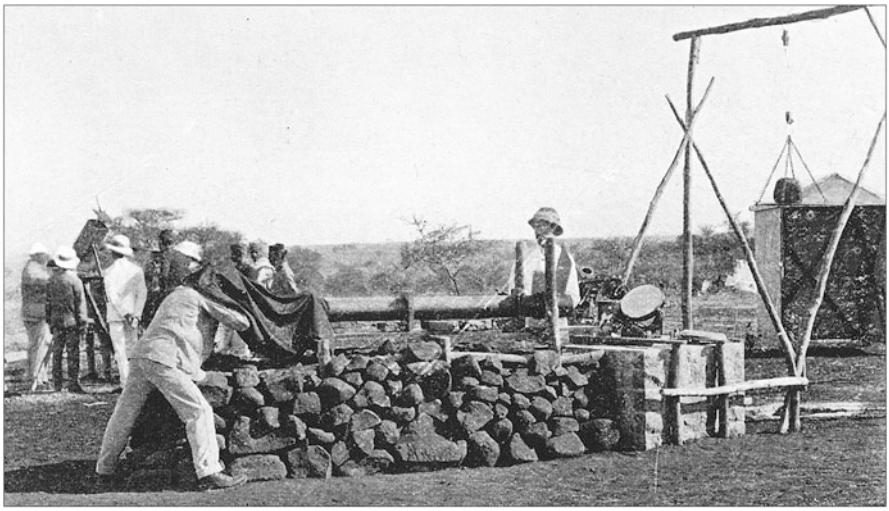


Fig. 4 A photograph of Naegamvālā's horizontal photoheliograph, showing the heliostat that was driven to track the Sun, and the tube that led to the spectrograph, which was located under the black cloth cover (after Maunder 1899: 81)

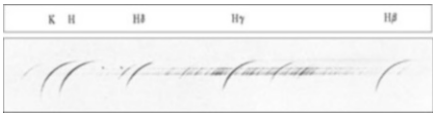


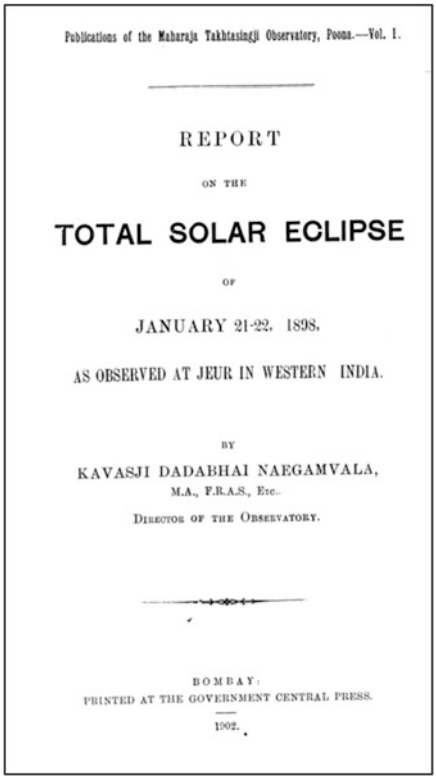
Fig. 5 The photograph of the 'flash' spectrum published in the Astrophysical Journal (after Naegamvala 1898)

shown on the original." He also commented that perhaps the most interesting feature of the photograph was the prominence that was shown in two lines, H and Hδ, but was invisible in the H and K and the hydrogen lines (Naegamvala 1898: 121).

Naegamvālā then proceeded to prepare a monograph on the expedition, and this was published in 1902. The front cover is shown in Fig. 6 and the Contents are listed in Table 1.

A copy of this book is available in the Library of the Indian Institute of Astrophysics in Bangalore, a pdf copy of which can be used online, and is available through the website of the National Digital Library of India (NDL).

The Contents list in Table 1 obviously is not comprehensive. However, it gives an idea about the hard work done by K.D. Naegamvālā in managing the programme and eventually in compiling this Report. The list of his co-observers contains also many students, along with his son, (Master) P. Naegamvala and presumably his brother or cousin, R.D. Naegamvala. The most important sections of the Report are those about the 'flash' spectrum and the coronal photographs. Here I may cite his opinion:


Publications of the Maharaja Takhtasingji Observatory, Poona.—Vol. 1.

REPORT

ON THE

TOTAL SOLAR ECLIPSE

OF

JANUARY 21-22, 1898,

AS OBSERVED AT JEUR IN WESTERN INDIA.

BY

KAVASJI DADABHAI NAEGAMVALA,

M.A., F.R.A.S., Etc.

DIRECTOR OF THE OBSERVATORY.

BOMBAY:

PRINTED AT THE GOVERNMENT CENTRAL PRESS.

1902.

Fig. 6 The front cover of Naegamvālā's Report on Solar Eclipse of 1898 (courtesy: Dr. Silloo M. Vacha (Poona) et al.)

> From the first I had proposed to concentrate powers of the expedition in the spectroscopic lines, assigning a secondary place to the subjects of observations . . . but for the late arrival of the instruments and the programme . . . finally was adopted as follows. (Naegamvala 1902).

On pages 6 and 7 in his Report Naegamvālā lists 14 important aspects of the observations. Of special interest is his drawing of the corona, shown here in Fig. 7 (cf. Fig. 8).

Finally, I may add the following. The importance of this particular total solar eclipse, particularly for coronal photography can be gauged from the fact that a Joint Eclipse Committee of the Royal Society and Royal Astronomical Society was set up—headed by the then Astronomer Royal Sir William Christie—to take an expedition to India for the eclipse, but also to report on the status of Indian observatories. Christie toured India to gain first-hand knowledge of the observatories at Bombay, Madras and Kodaikanal (and he also successfully observed the eclipse). His Report, which was printed in 1898, is 17-pages long and contains nine sections (Christie 1898a). Meanwhile, an abbreviated version was published in the *Proceedings of the Royal Institution* (Christie 1898b).

Table 1 Table of contents of Naegamvālā's report

Table
Outline of Contents of K.D. Naegamvala's Report on the Total Solar Eclipse of 1898
Prefatory Remarks: "...Regarding the delay in publishing the report of Eclipse", signed by K.D. Naegamvala, November 1,1901
Contents: List of XXXII Sections from p. 1 to p. 67.
List of 44 Illustrations, contains also list of Plates from I to XXX.
Chapter I: Preliminary Preparation, Sections I to VI.
Chapter II. Eclipse Observations, starting from Sec. VII, for instance,
. . . . .
Sec. X. Personnel and Programme of Work, containing list of 14 instruments, Issued to various observers.
Sec: XVIII. The Flash Spectrum,
Section XXI. The Coronal Spectrum, containing list of previous observations of 13 years (1868? 1900), furnished with references.
Section XXIII. The Coronographs: Photography of the Corona,...
Section XXX. Meteorological Observations.
Appendix. Instructions for observing the Total Eclipse of the Sun, at Jeur on Jan. 22,1898.
. . . . .
Plate VI. Photograph of the Observing Party, with printed list of names of 52 members.
Plate IX. Spectrum of the Flash with Figs. 1 and 2.
Plate XXVI. Sketch of the Corona made by Rev. A. Abbott.

Fig. 7 A composite drawing of the corona based on photographs (after Naegamvālā 1902)

Christie's reports reveal that there were actually four official British observing parties:

1. Sir Norman Lockyer and Alexander Pedler (1849–1918), Director of Public Instructions in Bengal, led a team that observed the eclipse at Viziadurg, from a British ship.
2. William Christie and Oxford University's Professor H.H. Turner (1861–1930) were based at Sahdol.
3. Soldier-astronomer Captain E.H. Grove-Hills (1864–1922) and Cambridge University's H.F. Newall (1857–1944) were at Pulgaon.
4. The party led by Astronomer Royal of Scotland, Dr. Ralph Copeland (1837–1905) was based at Ghoglee (for all localities see Fig. 3).

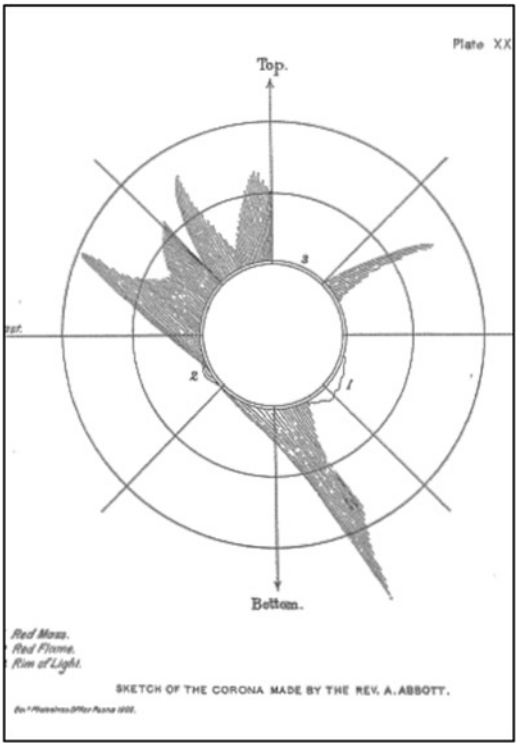


Fig. 8 A sketch of the corona by the Reverend A. Abbot (after Naegamvala 1902: Plate XXVI)

In addition to these parties sponsored by the Royal Society and Royal Astronomical Society,

> The British Astronomical Association (BAA) mounted an ambitious expedition, using two observing sites, and in a copiously-illustrated 184-page book, Edward Maunder (1899) provides a detailed account of this venture by some of Britain's leading amateur astronomers . . . (Orchiston and Pearson 2017).

The large BAA party split into two teams. One of these was based at Buxar and carried out photographic observations, while the second, led by Edward W. Maunder and based at Talni, focussed on spectroscopic observations. John Evershed (1864–1956) and Michie-Smith from Kodaikanal Observatory joined Maunder's team (see Maunder 1898, 4–28).

All this underscores the significance of the eclipse of 1898, when an Indian team headed by Naegamvālā contributed substantially.

8 Discussion

8.1 Working Conditions

As to the working environment, Naegamvālā had been researching in difficult conditions. He had to hold a teaching position at the College of Science, and he worked simultaneously as the Director of the Observatory. In fact he confessed to Astronomer Royal Christie:

> As long as I am required to teach Physics . . . it would be idle to expect me to have energy or time to accomplish anything . . . (Naegamvala 1896).

This did not turn out to be exactly true, for despite his double appointment he was engaged in preparations for the 1898 solar eclipse, which he specifically mentioned in his Report (Naegamvala 1902: 1–2). On 23 February 1896, he approached the Government of Bombay to convince it of the importance of the total solar eclipse of 1898, and to secure a grant so that he could view the total solar eclipse on 9 August 1896 from Norway (in order to familiarise himself with the correct observing techniques), and so that he could acquire modern equipment for the Indian eclipse of 1898. Fortunately, the Government approved his request.

However, despite of his best efforts and capabilities, Naegamvālā could not secure a graded Government post, even up to 1899, although back in 1887 the Government had already recognised that he was "... practically qualified for a graded appointment." (Naegamvala 1899: 6).

Noteworthy here is another Report on Indian Observatories by the Director of the Solar Physics Observatory at South Kensington, Sir Norman Lockyer (FRS), which was compiled at the request of the India Office in London. In this, Lockyer (1898: 32–33, 37) depreciated the non-astronomical routine work carried out at these observatories and recommended strongly that the astronomers should be free to spend more time on pure research. An important outcome of this Report was that Naegamvālā be relieved of teaching duties so that he could devote all his time to research at Takhtasingji Observatory, and that he would communicate the results of his solar observations to Lockyer. And

> If Lockyer had had his way, he would have appointed Naegamvala the director of the proposed Solar Physics Observatory at Kodaikankal. (Kochhar and Narlikar 1995: 18; cf. The observatories of India 1899: 309).[2]

However, the successful applicant was Madras Observatory Director, Charles Michie-Smith.

[2]Cf., also, page 2 in a three-page printed Memorial in Family Papers.

8.2 *Naegamvālā's International Standing*

Naegamvālā's spectroscopic and photographic observations brought him worldwide recognition. In his book, *The Indian Eclipse of 1898*, Edward W. Maunder (1899) mentions Naegamvālā's research, and he also is cited by Agnes Clerke (1842–1907; Brück 2002) in her masterful tomes *A History of Astronomy during the Nineteenth Century* (1893: 302) and *Problems in Astrophysics* (Clerke, 1903: 46, 94). Naegamvālā (1899: 3–4) was particularly proud of this first citation.

Meanwhile, the famous Indian astronomer M.K. Vainu Bappu (1927–1982), founding Director of the Indian Institute of Astrophysics in Bangalore and the inspiration behind the Vainu Bappu Observatory at Kavalur, had this to say: "Naegamwala's solar work is the first complete Indian efforts of its kind on record." (Bappu 1974–75: 9). He also praised Naegamvālā's solar eclipse observations:

> The report of this successful expedition indicates the great care and thoroughness that went into the planning of the expedition. (Bappu 1974–75: 13).

Much earlier, Sir Norman Lockyer (1898: 21) had voiced a similar opinion when he evaluated Naegamvālā's spectroscopic observations of the 1898 solar eclipse, describing him as

> . . . the only person in India at that time who was well qualified to carry out worthwhile investigation into solar physics.[3]

8.3 *Naegamvālā, Michie-Smith and the Founding of the Kodaikanal Observatory*

It is appropriate here to say a few words about the establishment of the Solar Observatory at Kodaikanal.

Despite his extensive international connections, it is known that Naegamvālā did not have contact with other astronomers working in India, so initially he may have been completely unaware of the developments that led to the establishment of the first solar physics observatory in India, particularly the efforts by Madras Observatory Director Norman Pogson (1829–1891), and after his retirement in 1891 by Charles Michie-Smith (1854–1922)—who was actually the main spirit behind the establishment of Kodaikanal Observatory (see Ansari 1985: 26–28). In a recent paper Kameswara Rao et al. (2014b) trace the developments that led eventually to the actual establishment of the observatory at Kodaikanal, between 1892 and 1895. In fact, as I pointed out previously:

> The Indian Observatories Committee by its resolutions on 26 Oct.1892 (Chairman Lord Kelvin) and on 20 July 1893 (Chairman President of RAS) approved the establishment of a

[3] In addition, an unattributed remark in the Bombay Archives (No. 799, dated 23 June 1899), states that "Naegamvala earned a name in three continents."

> Solar Physics Observatory at Kodaikanal under the directorship of Michie Smith. (Ansari 1977: 255).

In October 1895, the foundation of the new Observatory was laid by the Governor (Kameswara Rao 2014b: 457–458).

It is possible that Naegamvālā only learnt of these developments when he discussed the future of solar astronomy in India with William Christie and newly knighted Sir Norman Lockyer at Jeur in 1898, but by this time it was 'too little too late', so at least he might have thought to secure the status of Takhtasingji Observatory as an astrophysical observatory in order to ensure that it would survive after his retirement. But he did not do this.

Perhaps Naegamvālā was unhappy—even bitter—about the Kodaikanal appointment for it is significant that after the 1902 solar eclipse monograph appeared he published no more research papers, and he seems to have made little use of the 20-in telescope or the other facilities at Takhtasinghji Observatory (Kochhar and Orchiston 2017).

8.4 The Fate of Takhtasingji Observatory and Its Instruments

It was fateful irony that the Government of India decided, after Naegamvālā retired in 1912, that Takhtasingji Observatory would be closed and the instruments transferred to the Solar Observatory at Kodaikanal (Sohini 1951: 5–7). Thus, a purely Indian initiative to promote astrophysics in an Indian educational institution was nipped in the bud. Note, in this context, that Nizamiah Observatory at Osmania University (in Hyderabad) was founded in 1901, but only became fully operational in 1908.

The Government directive was carried out, and all of the Takhtasingji Observatory instruments were transferred to Kodaikanal Observatory in 1912. When the 20-inch reflector reached Kodaikanal it finally fulfilled a longstanding dream of former Madras Observatory Director, N.R. Pogson, to install such a telescope at a hill station:

> It was the largest telescope in the country at that time and served as the principal instrument for stellar observations for a long time. (Bhattacharyya and Vagiswari 1985, 413–414).

Later it was renamed the Bhavnagar Telescope, and has been described by Kameswara Rao et al. (2014a) as "... the most widely travelled telescope in the country." As they noted, after arriving at Kodaikanal Observatory

> It took different forms and configurations ... From Kodaikanal it went to Kavalur and then to Leh and back to Kodaikanal [where it remains]. (Kameswara Rao et al. 2014a: 619).

Unfortunately, there are no photographs of this famous historic telescope in its Grubb 16.5-in or a Grubb/Common 20-in Takhtasingji Observatory configurations, but there is an image of it taken during the 1980s, when it was located at Leh for site-testing, and this is reproduced here in Fig. 9.

Fig. 9 A photograph of the 20-in Bhavnagar Telescope when it was at Leh between 1984 and 1988 (adapted from Kameswara Rao et al. 2014a: 619)

9 Concluding Remarks

On the basis of original records extant in Bombay Archives and Family Papers of Naegamvālā, I have tried in this paper to relate the story of the first astrophysical observatory in India and of its Director, K.D. Naegamvālā.

However, I need to record here that the first brief preliminary report on Takhtasingji Observatory in Poona was published by me already in 1977 as a short section in a general history of the early development of Western astronomy in India, which was actually the topic of my talk at the Tercentenary of the Royal Greenwich Observatory, held at Greenwich (14–18 July 1975). I then tried to update this on the basis of original archival records available at the Maharashtra Government Archives (Bombay) and Family Papers of K.D. Naegamvālā, on the occasion of the General Assembly of International Astronomical Union that was held in New Delhi in 1985 (see Ansari 1985: 36–40). I collected and included in my account data drawn from records in the Royal Greenwich Observatory Archives, which were later moved to Herstmonceux Castle. However, I do not claim to have conducted a definitive search, as far as the available Indian and international archival records are concerned.

To my mind the following questions require answers, if we are to understand the early history of the development of observational astrophysics in India:

1. Why didn't Naegamvālā keep up-to-date with the general development of astronomical physics in India during the last decade of the nineteenth century?
2. Since Naegamvālā's work was recognised by famous foreign astronomers, why didn't he establish formal connections with relevant British Government officials in New Delhi, either directly himself or through Norman Lockyer?
3. Why didn't Naegamvālā hire any assistant to help him increase his observations and the output of publications?
4. What did he do after retirement in 1912? He only passed away in 1938 (more than two and a half decades later)?

I hope that some young historian of astronomy under the supervision of a senior astronomer may be motivated to collect further relevant data from records in England, at the India Meteorological Department in New Delhi and at the archives at Kodaikanal Observatory, and thereby study more thoroughly Naegamvālā's contribution to Indian and international astronomy.

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