

C. RAGOONATHA CHARRY AND VARIABLE STAR ASTRONOMY

N. Kameswara Rao, A.Vagiswari, Priya Thakur and Christina Birdie

Indian Institute of Astrophysics, Koramangala, Bangalore 560 034, India.

E-mails: nkrao@iiap.res.in, vagiiap@iiap.res.in, priya@iiap.res.in, chris@iiap.res.in

Abstract: C. Ragoonatha Charry, the First Assistant at Madras Observatory from 1864 to 1880, was not only a noted Indian observational astronomer but also someone who emphasized the need for incorporating modern observationally-based improvements into the traditional Indian methods of astronomical calculations. He was one of the first to argue for the establishment of an independent modern Indian observatory for education and training. He is credited with the discovery of two variable stars, R Reticuli and one whose identity is now the subject of debate. In this paper we provide background information about Ragoonatha Charry and his work at the Madras Observatory, and then discuss his variable star discoveries.

Keywords: Indian astronomy, Madras Observatory, Ragoonatha Charry, solar eclipses, variable stars, R Reticuli, U Cephei

1 INTRODUCTION

The phenomenon of stellar variability is of great importance in many areas of astrophysics, including stellar structure, stellar evolution, distance scales (through period-luminosity relations), dust formation, etc. The systematic study of variable stars began in the mid-nineteenth century, there only being eighteen known variable stars in 1844 (Hogg 1984). The status of variable star research around this time has been summarized by Clerke (1903), Hogg (1984) and Orchiston (2000), amongst others, and it was only pursued by a few enthusiasts, such as Norman Pogson, Joseph Baxendall and Friedrich Argelander.

The study of variable stars was not always thought appropriate for British colonial government-supported observatories like the Madras Observatory in India. Originally set up in 1786 as a private observatory by William Petrie, an officer in the British East India Company, in 1810 it came under the control of the Surveyor General of Madras (Kochhar, 1991). Although the Observatory "... had a chequered history for more than a hundred years ..." (Kochhar, 1985: 288), its main purpose was to produce catalogues of stellar positions from meridian observations (Taylor, 1832-1848). This situation changed to a degree in 1861 when Norman R. Pogson (1829–1891) was appointed Government Astronomer. Pogson was a pioneer variable star observer and was well known for developing the stellar magnitude scale. He introduced the observation of variable stars as a regular part of the Observatory's research programme¹ and inspired people like C. Ragoonatha Charry, one of the Indian staff members, to enthusiastically pursue this line of work. In this paper we provide biographical information on Ragoonatha Charry before discussing his variable star discoveries.

2 C. RAGOONATHA CHARRY: A BIOGRAPHICAL SKETCH

Chinthamani Ragoonatha Charry² (Figure 1) was a rather private person, so not much is known about his non-professional life. However, Dikshit (1981: 181) gives his date of birth as 17 March 1828 (even though this information is missing from his RAS obituary—see Obituary, 1881)

According to Venkateswaran (2009), Ragoonatha Charry came from a family of panchang (almanac) makers, and despite his apparent expertise in inter-

preting and analyzing Sidhanthic astronomy texts, Dikshit (1981: 181) points out that Ragoonatha Charry was not very proficient in Sanskrit.

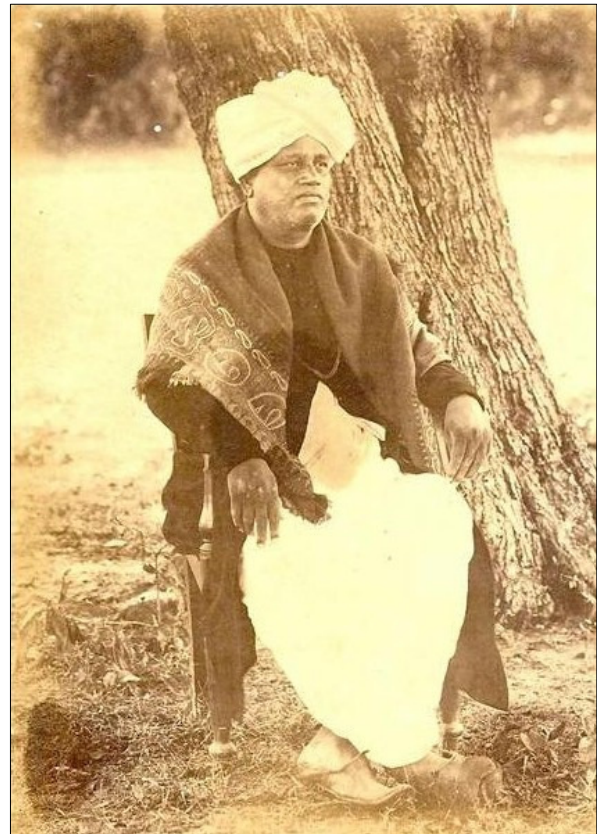


Figure 1: Ragoonatha Charry at Madras Observatory (from the collection of Ms Cherry Armstrong, the great-great-granddaughter of N.R. Pogson).

Ragoonatha Charry became a skilled observer by hard work and devotion. He joined the Madras Observatory at the age of 18 (Venkateswaran, 2009) and eventually rose to the position of First (or Head) Assistant to the Astronomer. He not only made calculations and observations at the Observatory and discovered two new variable stars, but when he was off duty he continued to observe at his own residence with his own instruments.³ The 1867 issue of the *Madras Almanac* reveals that Ragoonatha Charry lived in Nun-gumbakam village close to the Observatory. Pogson (1872b) remarked in a footnote to his log sheets listing observations of an occultation of Venus on 3 Novem-

ber 1872 that Ragoonatha Charry observed the event “... from his private residence about five eighths of a mile distant nearly due south of the observatory.”

A self-taught man, Ragoonatha Charry (1868b) acquired the mathematical knowledge to be able to accurately predict the occultation of stars in the Sun’s path during the total solar eclipse of 1868. According to Pogson (1861a), Ragoonatha Charry “... possessed sufficient skill and energy to make additional observations, worthy of the reputation of the Observatory and beneficial to science.”

Ragoonatha Charry holds a special place in the annals of Indian astronomy in that he was the first Indian-born astronomer to publish a paper—albeit a short one—in the *Monthly Notices of the Royal Astronomical Society* (Ragoontha Charey, 1859) and was the first Indian to become a Fellow of the Society (Obituary, 1881). He was proposed by Pogson and by E.B. Powell, the Director General of Public Instruction in the Madras Presidency, and was elected on 12 January 1872.

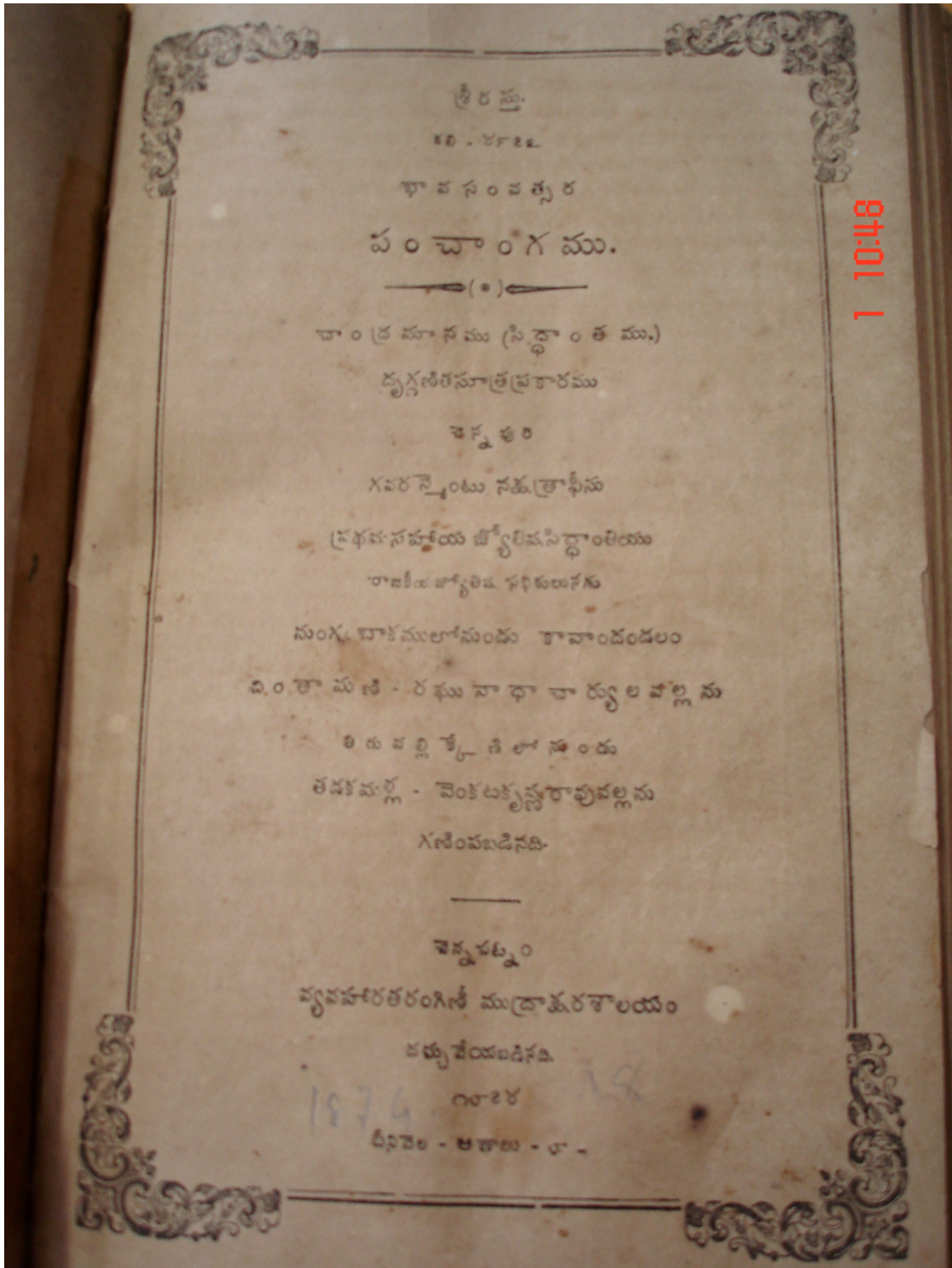


Figure 2: An example of one of the almanacs, in the language of Telugu, prepared by Ragoonatha Charry at his own expense (courtesy Theosophical Society, Chennai).

Not only was Ragoonatha Charry a keen observer (who devoted almost his whole life to observational astronomy at the Madras Observatory), but more importantly, he was a passionate promoter of modern science and astronomy and a reformer who endeavored to integrate modern observational results and phenomena into the classical Sidhantic astronomy which was traditionally practiced at that time. His efforts in formulating and bringing out the *Drigganita Panchang* (an almanac based on observations—see Figure 2) for several years is well described by Venkateswaran (2009). The author of his Obituary (1881) commented on his ambitious efforts to write a two-volume treatise titled *Jyotisha Chintamani* that would contain rules, formulae and tables based on British methods of calculation for the guidance of Sidhantis. Ragoonatha Charry (1874) also championed the cause of observational astronomy by urging people to raise funds "... to establish an observatory, to serve as a school for the instruction of Hindu students desirous to qualify in practical astronomy." He further emphasized (ibid.):

I earnestly commend this movement (raising funds for an observatory as well as to help publish his treatise) to all native noblemen and wealthy gentlemen in the Presidency (Madras), as well as throughout India, who are interested in the improvement of their fellow countrymen, and beg them to join heartily in a design which aims at promoting a most fascinating branch of knowledge, the cultivation of which although under besetting difficulties and imperfections, is now and always has been highly prized by Hindus throughout the country.

Limited information is available about Ragoonatha Charry's family. Dikshit (1981: 182) mentions that his son Chinthamani Raghava Charry assisted him in the preparation of the *Drigganita Panchang* for the year 1880. Meanwhile, in 1877 Ragoonatha Charry had

arranged for his brother-in-law, P. Raghavachari, to join the staff of the Madras Observatory, and just like his distinguished relative he too would eventually rise to the rank of First Assistant (ibid).

We know that Ragoonatha Charry participated in a range of socially-beneficial activities. For example, he was the Executive Committee President of the Madras Hindu Janopakara Nithee (the General Benefit Fund) established at Pursewakum on 1 February 1861. The management of the Fund was entrusted to a Committee of sixteen members (*Madras Almanac*, 1867). In addition, along with his Madras Observatory colleague, T. Mootosawmy Pillay, Ragoonatha Charry served as an Executive Committee Trustee of the Madras Hindu Draviya Sakara Nidhi (Saving Fund) that was established in Nungumbakam on 1 July 1861 (ibid.). For twelve years he edited the astronomical section of the Asylum Press Almanac (Obituary, 1881), and he is also known to have given public talks on various astronomical and other scientific topics (ibid.).

3 RAGOONATHA CHARRY'S CAREER AT THE MADRAS OBSERVATORY

Ragoonatha Charry (Figure 3) had a career at the Madras Observatory that spanned about forty years. He was recruited by T.G. Taylor in 1847 (Dikshit, 1981: 181) and worked with successive Directors, W.S. Jacob (who communicated his first paper to *Monthly Notices of the Royal Astronomical Society*), W.K. Worster, J.F. Tennant and N.R. Pogson. All four were impressed by his astronomical skills.



Figure 3: In this photograph, we believe Ragoonatha Charry is the person wearing the white turban seventh from the left. Seated beside him and to his right is N.R. Pogson (with the beard, but without a hat). This photograph was possibly taken at the Madras Observatory during 1871, around the time of the December total solar eclipse (from the collection of Ms Cherry Armstrong, great great grand-daughter of N.R. Pogson).

Ragoonatha Charry's main mentor at Madras Observatory, however, was Pogson. Soon after his arrival at Madras, Pogson announced the discovery of the minor planet 'Asia', the first from this part of the world (Pogson, 1861a; 1861b), and made complimentary remarks about Ragoonatha Charry's participation: "... the second observation, on 20 April, was taken and reduced by my fourth native assistant, Ragoonatha Charry, who readily comprehends and most willingly executes whatever I may recommend to his notice."

Pogson also encouraged Ragoonatha Charry's zeal in communicating modern developments in astronomy to the general public and making them aware of the physical nature of celestial events so as to dispel traditional superstitions. The two pamphlets that Ragoonatha Charry prepared for the benefit of the general public about the 18 August 1868 and 12 December 1871 total solar eclipses that were visible from South India (e.g. see Ragoonatha Charry, 1868a) received considerable support. The one describing the 1871 eclipse, which was brought out in four regional languages, was strongly endorsed and recommended by Pogson, who applied to the Chief Secretary of the Madras Government for financial assistance:

... consider it well calculated to instruct and at the same time to dispel the superstitious fears of the ignorant native masses, while it goes further and by its quotations from the puranahs, and other weighty arguments show that the absurd notions which render eclipses so alarming are not authorized by their own religious writings. He also shows by comparison of results, the vast inferiority and great inaccuracy of the calculations of Hindoo astronomers and urges them to abandon their worthless methods and antiquated tables and avail themselves of modern improvements. (Pogson, 1871a).

The 1868 eclipse played an important role in expanding astronomical knowledge of the solar corona (e.g. see Orchiston et al., 2006), when the element helium was discovered. Ragoonatha Charry was given the responsibility of conducting observations from Vunparthy, a village located forty-five miles north of Kurnool. He unfortunately experienced cloudy weather and could only comment on the degree of darkness witnessed during the eclipse.

Ragoonatha Charry was one of the key people chosen for the Madras Observatory's expedition to Avenashy (in the Coimbatore District) to conduct observations during the 1871 total solar eclipse. Pogson (1871a) describes his role:

... general observations, consisting of careful micro-metrical measurements of the cusps, of conspicuous prominences, of the extent and figure of corona, amount of darkness, visibility of stars, and accurate times of the various phenomena, may be chiefly entrusted to C. Ragoonatha Charry, the first Native assistant.

During the 6 June 1872 annular solar eclipse, which was visible from the Madras Observatory, Ragoonatha Charry made similar coronal observations with the Lerebours equatorial (Pogson, 1872a).

However, Ragoonatha Charry's principal role at the Madras Observatory was to make routine observations of stars and to reduce them for the Madras Catalogues, which he did until 1878, when his deteriorating health prevented him from continuing. The main instrument that he worked with was a meridian circle, which was installed at the Observatory in 1862 (Sen, 1989).⁴ By

the end of 1878, 35,681 observations had been made, a fair number of them by Ragoonatha Charry.

4 RAGOONATHA CHARRY'S VARIABLE STAR WORK

Soon after Pogson joined the Madras Observatory as Government Astronomer in 1861 he included variable stars and minor planets in the main observational programmes of the Observatory. At this time, the total number of known long period variables was 55 (although it rose to 60 in 1862; see Pogson, 1861c). Pogson was a pioneer variable star observer, discovering 21 new variables while at Oxford and Madras Observatories. During his time at Madras Observatory he published annual variable star ephemerides in *Monthly Notices of the Royal Astronomical Society*, and he also prepared a catalogue of observations he made of thirty-one different variable stars which was published posthumously in 1908 through the actions of Brook and Turner.

Pogson included several known variable stars in the regular observing programmes of the Madras Observatory, even with the meridian circle. For example, the irregular variable R Coronae Borealis was observed at different times between 20 May and 4 July 1863, and was found to vary between magnitude 6.1 and 9.0. Ragoonatha Charry contributed four of these observations on three occasions, the others being made by his Indian colleague, Mootoosawmy Pillay. The magnitude scale adopted for these observations was earlier devised by Pogson (see Pogson, Brook and Turner, 1908). Ragoonatha Charry's observations were later utilized by Webbink (1978) in re-identifying the recurrent nova U Scorpii that was discovered as a variable by Pogson on 20 May 1863.

Because of this new and exciting area of activity undertaken by Madras Observatory, Ragoonatha Charry became an experienced variable star observer. It is no surprise, therefore, that he should discover new variable stars, and these are discussed below.

4.1 R Reticuli

Ragoonatha Charry discovered the variability of R Reticuli in January 1867. Pogson (1868) describes this event in the *Annual Report of the Madras Observatory*: "The detection of a new and interesting variable star, far south, is due to the First Native Assistant C. Ragoonatha Chary."

R Reticuli was first observed by Mootoosawmy with the meridian circle on 9 February 1864, and seemed like an ordinary star of magnitude 8½, but when next looked for, in January 1866, it was no longer visible in the dark field of the meridian circle telescope, which was 5.5 inches in aperture. It must therefore then have been fainter than magnitude 12. It was, however, observed again on 16 January 1867, this time by Ragoonatha Charry, and its variability was thereby established. Subsequent magnitude estimates made over twenty-six different nights up to 7 April 1868 showed that it attained a maximum brightness of 7¾ about the middle of February, and that its period was about nine months. For epoch 1 January 1860 the co-ordinates of this star were Right Ascension 4h 32m 6.1s and North Polar Distance 153° 19' 14". Figure 4 lists the observations of R Reticuli that were made at the Madras Observatory in 1867.

R Reticuli was later closely followed at both Madras and Harvard Observatories (see Pogson, Brook, Turner, 1908, and Campbell, 1926), and is now known to be a large amplitude Mira-type variable with a period

of 278.32 days, a $(B-V)_0$ of 1.34 and $E_{(B-V)} = 0.11$. The spectral type varies between M4e and M7.5e. Allen et al. (1989) discovered it to be a SiO maser source at 86 GHz.

Number and Date.	Magnitude.	Mean Right Ascension 1867.			No. of Wires.	Mean Polar Distance 1867.			Observer.
		h.	m.	s.		°	'	"	
160 <i>U Tauri</i> Var. 7.									
Jan. 17	9.9	4	14	4.25	...	70	30	15.3	R
161 <i>Anon.</i>									
Nov. 16	10.0	4	15	20.86	5	129	7	25.1	R
162 <i>Anon.</i>									
Nov. 14	8.0	4	16	49.23	...	149	3	59.5	M
163 <i>74 Tauri</i> ε									
Jan. 4	...	4	20	51.23	...	71	7	3.0	M
8	...	20	51.04	...	...	7	4.2	M
9	...	20	51.07	...	...	7	3.9	M
10	...	20	51.10	...	...	7	3.8	M
11	...	20	51.20	...	...	7	3.3	M
12	...	20	51.20	...	...	7	3.0	M
14	...	20	51.24	...	...	7	3.3	R
Oct. 15	...	20	50.97	...	...	7	3.5	M
Dec. 9	...	20	51.19	...	...	7	3.4	M
16	...	20	51.07	...	...	7	3.1	R
19	...	20	51.16	...	...	7	2.2	R
164 <i>Lacaille</i> 1519.									
Jan. 7	7.0	4	25	37.48	5	153	5	43.2	M
165 <i>Lacaille</i> 1520.									
Jan. 10	7.7	4	26	44.46	...	147	29	39.6	M
166 <i>Anon.</i>									
Dec. 13	9.3	4	27	15.77	6	150	33	35.1	M
167 <i>87 Tauri</i> α, <i>Aldebaran</i> .									
Jan. 3	...	4	28	17.46	...	73	45	39.9	M
5	...	28	17.57	...	...	45	39.6	M
8	...	28	17.37	...	...	45	41.1	M
9	...	28	17.46	5	...	45	40.7	M	
12	...	28	17.43	...	...	45	41.5	M
14	...	28	17.48	...	...	45	39.1	R
168 <i>Anon.</i>									
Jan. 4	8.3	4	28	32.46	5	110	13	54.9	M
Nov. 14	8.1	28	32.50	...	...	13	53.0	M
169 <i>R Reticuli</i> Var. 1.									
Jan. 16	10.0	4	32	10.56	6	153	18	22.0	R
17	9.8	32	10.21	...	...	18	22.2	R
23	9.5	32	10.40	...	...	18	21.2	R
Feb. 1	8.6	32	10.31	4	...	18	21.4	M	
15	7.7	32	10.49	...	...	18	19.3	M
Nov. 16	9.3	32	10.56	5	...	18	20.4	R	
Dec. 14	7.8	32	10.14	...	...	18	20.0	M
170 <i>Lacaille</i> 1551.									
Jan. 24	6.0	4	32	11.35	5	153	5	52.9	R
171 <i>Anon.</i>									
Dec. 16	9.2	4	34	39.80	...	153	26	30.7	R
21	9.7	34	39.84	5	...	26	31.5	R	
172 <i>95 Tauri</i> .									
Jan. 8	6.9	4	35	10.70	4	66	10	0.0	M
173 <i>Lacaille</i> 1567.									
Jan. 15	5.0	4	35	13.10	5	152	20	26.5	R
174 <i>Lacaille</i> 1566.									
Jan. 10	6.9	4	35	48.90	...	148	28	6.2	M

Figure 4: Madras Observatory observations of R Reticuli made in 1867 (after Pogson, 1887: 249).

4.2 Ragoonatha Charry's Mysterious Second Variable Star Discovery

Ragoonatha Charry's obituary that appeared in the *Madras Mail* on 7 February 1880 mentions that he also discovered another variable star, V Cephei, in 1878. This discovery is also mentioned in the obituary for Ragoonatha Charry that appeared in *Monthly Notices of the Royal Astronomical Society* (Obituary, 1881) but the source is attributed to the *Madras Mail*. However, the *Madras Almanac* of 1880 lists the new variable star as U Cephei. Surprisingly, no mention of the discovery of any new variable star (V Cephei or U Cephei) is made in Pogson's annual reports of Madras Observatory for 1878 or 1879. This is strange since Pogson liked to champion variable stars, and took great pleasure in writing about the discovery of R Reticuli.

Moreover, the discovery of the variability of V Cephei ($V = 6.59$, $B-V = 0.05$, $U-B = 0.05$, spectral type A3V) is normally credited to S.C. Chandler in 1882 (Chandler, 1890; 1896), who found a variation of 0.7 magnitudes and assumed the star to be either a long period or an irregular variable. Hoffleit (1985) discusses the variability of V Cephei in detail, as some early observers, including W.J. Luyten, found this star to vary by ~ 0.5 magnitude whereas neither E.C. Pickering nor Harlow Shapley could find any evidence of variation in its light. Nor does the spectral type (A3V) support the existence of pulsation. Milton, Williams, and Hoffleit (1988) discussed the nature of V Cephei on the basis of photometric observations and were able to show that the star did not vary by more than 0.02 magnitudes during a 428-day interval. They concluded that it was most unlikely that this star was a variable.

Let us now examine the discovery of the variability of U Cephei. This is generally credited to W. Ceraski (1880), who discovered the variation on 23 June 1880 (i.e. after Ragoonatha Charry's death). This star is a well known Algol-type binary with a period of 2.49 days. Soon after the discovery, Pogson's brother-in-law and nephew, Joseph Baxendell and Joseph Baxendell Junior, respectively, observed this star (see Yendell, 1903). Had the variability of this star been discovered earlier at the Madras Observatory it is hard to believe that they would have been unaware of this fact, yet they make no mention of it. Other early observations of U Cephei are discussed by Yendell, (1903) and Shapley (1916), but neither mentions Ragoonatha Charry as the discoverer.

So which variable star—if any—did Ragoonatha Charry discover in 1878? Upon consulting the *Results of Observations of the Fixed Stars Made with the Meridian Circle at the Government Observatory, Madras, in the Years 1877, 1878, 1879* (Pogson and Smith, 1893) we find an entry, "U Cephei, var 5" (see Figure 5) which lists the times of observations of this star, its magnitude, the mean positions for 1878 and the observer. It was observed on five different occasions by the following observers: Raghavachari (R), Ragoonatha Charry (C.R) and Mootoosawmy Pillay (M). The position of the object as listed by all the observers is the same, but the magnitude is said to have varied from 5.0 to 9.0. The fainter magnitudes (i.e. 8.2 and 9.0) were recorded by Ragoonatha Charry.

The same star was observed in 1880 (Figure 6) and listed in *Results of Observations of the Fixed Stars Made with the Meridian Circle at the Government Observatory, Madras, in the Years 1880, 1881, 1882* (Pogson and Smith 1894) as "U Cephei, Var. 5".⁵ On this occasion it was observed on five different dates by Mootoosawmy Pillay, and varied between magnitudes 6.5 and 7.0 magnitude (i.e. 1.5 to 2 magnitudes fainter than the brightest that was observed in 1878). Usually 'Var. 5' refers to the fifth variable discovered in the constellation. In Argelander's notation it should refer to V Cephei rather than to U Cephei (which was fourth variable discovered). More importantly, the coordinates given in Pogson's 1887 and 1893 catalogues do not match those of either U Cephei or V Cephei; indeed, the star referred to in the Madras Observatory catalogues is more than 2 hours west of and 13° south of V Cephei and more than 3 hours west of and more than 11.5° south of U Cephei.

This being the case, what is the name of the star that is mentioned in the two Madras catalogues? A search of a 10 arc minute field around the reported position revealed the presence of HR 8342 (= HD 207636). We calculated the mean position of this star for epoch 1878 using the proper motion given by Simbad (Hipparcos) as $\alpha = 21\text{h } 44\text{m } 51.5\text{s}$ and $\delta = +69^\circ 35' 7.2''$. By comparison, the position of the variable star listed in the Madras catalogues is $\alpha = 21\text{h } 44\text{m } 51.4\text{s}$ and $\delta = +69^\circ 35' 8.1''$. The coordinates match very well indeed.

So the Madras variable can most likely be identified with HR 8342. However, HR 8342 is not known to be a variable, either in light or in radial velocity. The three measurements listed in Simbad on different occasions show a mean value of $-2 \pm 1 \text{ km s}^{-1}$. The spectral type is A0 V. The Hipparcos parallax gives a distance of 151 ± 10 parsecs and with a $V = 6.45$ the M_V obtained is 0.56, which is consistent with the spectral type of A0 V (Allen, 1973). The A0 V stars are not known to be variable, and certainly not by four magnitudes. The possibility that it could be a binary also seems unlikely. For example, the Algol system U Cephei has a primary of B8 V and a similar magnitude, $V = 6.92$. It shows light variations ranging from magnitude 6.9 to 9.2. However, the infrared colors clearly show an excess (for a B8 V star) suggesting the presence of a companion. The colors of U Cep are $B-V = 0.00$, $V-J = 0.45$, $V-H = 0.56$ and $V-K = 0.67$, whereas HR 8342 shows the following colors: $B-V = -0.008$, $V-J = 0.05$, $V-H = 0.01$ and $V-K = 0.036$, almost text book colors for an A0 V star without any color excesses. Thus, it is difficult to understand the light variability reported by Ragoonatha Charry and the other Madras observers. Yet they were experienced observers, so their magnitude estimates cannot be easily ignored.

The variability of 'U Cephei, var 5.' in the Madras catalogues therefore remains a mystery and the credit for the discovery of the variability of this star (what ever it happens to be) by Ragoonatha Charry must remain in doubt. Furthermore, it is somewhat surprising that observations of this star were not continued—let alone commented on—later, either by Pogson or by other astronomers at the Madras Observatory following Ragoonatha Charry's death in February 1880, as variable stars remained on the observing program.

5 CONCLUDING REMARKS

Rajesh Kochhar (1992; 1993) has outlined the three-phase development of science in India, from the time of initial European settlement through to the emergence of a purely Indian scientific tradition. During his long service at the Madras Observatory, Ragoonatha Charry was able to span two of these phases. First he was a prominent Indian astronomical assistant in the ‘peripheral native stage’ when Indians were hir-

ed and trained by Europeans to successfully perform scientific activities. But later in his career Ragoonatha Charry also could claim to belong to the ‘Indian response’ phase, as he passionately sought to promote the emergence of a modern—yet distinctly Indian—style of astronomy. In a public lecture that he gave at the Pacheappah’s Hall in Madras on 13 April 1874 his plea for a native observatory reflects this:

Number and Date.	Magnitude.	Mean Right Ascension 1878.			No. of Wires.	Mean Polar Distance 1878.			Observer.
		h.	m.	s.		o.	'	"	
873 <i>μ Cygni—2nd.</i>									
Oct. 1	...	21	38	41.34	...	61	48	28.1	C.B.
19	...	38	41.50	6	48	29.0	C.B.		
25	...	38	41.49	...	48	27.6	C.B.		
874 <i>9 Pegasi.</i>									
Sep. 24	4.5	21	38	43.96	...	73	12	31.2	R
30	4.5	38	44.17	4	12	29.7	R		
Oct. 21	5.0	38	43.94	...	12	31.9	C.B.		
875 <i>10 Pegasi κ</i>									
Sep. 23	...	21	39	7.10	...	64	54	54.2	R
28	4.0	39	7.25	...	54	54.6	R		
Oct. 24	4.7	39	7.12	...	54	54.0	C.B.		
876 <i>11 Cephei.</i>									
Nov. 14	4.6	21	40	7.88	...	19	14	59.6	M
877 <i>10 Cephei ν</i>									
Sep. 21	4.5	21	41	55.75	...	29	26	29.7	R
878 <i>81 Cygni π²</i>									
Oct. 4	...	21	42	16.98	...	41	15	16.1	C.B.
879 <i>14 Pegasi.</i>									
Sep. 27	5.0	21	44	26.71	...	60	23	35.0	R
30	5.0	44	26.77	...	23	34.3	R		
Oct. 21	5.0	44	26.78	...	23	36.4	C.B.		
23	5.0	44	26.70	...	23	34.3	C.B.		
880 <i>ν Cephei, var 5.</i>									
Sep. 18	5.0	21	44	51.40	...	20	24	51.9	R
19	5.0	44	51.32	...	24	51.5	R		
Oct. 17	8.2	44	51.80	6	24	52.7	C.B.		
22	9.0	44	51.44	...	24	52.9	C.B.		
Nov. 6	7.8	44	51.88	...	24	51.8	M		
881 <i>16 Pegasi.</i>									
Oct. 2	...	21	47	30.62	...	64	38	53.1	C.B.
3	...	47	30.66	...	38	52.4	C.B.		
882 <i>30 Aquarii.</i>									
Sep. 21	5.0	21	56	51.49	...	97	6	37.9	R
25	5.5	56	51.32	...	6	39.7	R		
27	5.5	56	51.37	...	6	38.9	R		
Oct. 21	5.7	56	51.27	...	6	40.7	C.B.		
24	...	56	51.40	...	6	38.9	C.B.		
883 <i>16 Cephei.</i>									
Oct. 1	...	21	57	29.91	5	17	24	0.9	C.B.
8	...	57	29.75	...	24	2.3	C.B.		
22	5.0	57	29.94	...	24	3.5	C.B.		
Nov. 8	5.0	57	30.28	...	24	3.0	M		
9	5.2	57	30.34	...	24	1.3	M		
884 <i>Anon.</i>									
Sep. 24	10.0	21	57	50.26	...	92	31	10.4	R
28	10.4	57	50.33	4	31	7.6	R		
Oct. 23	9.9	57	50.45	...	31	10.2	C.B.		
885 <i>34 Aquarii α</i>									
Oct. 3	...	21	59	30.94	...	90	54	42.7	C.B.
29	...	59	31.04	...	54	43.9	C.B.		
Nov. 2	...	59	30.92	...	54	43.4	C.B.		
6	...	59	30.99	...	54	41.7	M		
21	...	59	31.05	...	54	43.1	M		
886 <i>18 Cephei.</i>									
Oct. 17	5.5	22	0	13.74	...	27	28	24.1	C.B.
Nov. 11	5.4	0	13.97	...	28	24.0	M		
14	5.5	0	13.75	...	82	23.7	M		
887 <i>24 Pegasi ι</i>									
Oct. 24	4.0	22	1	19.87	5	65	15	0.5	C.B.

Figure 5: Madras Observatory observations of U Cephei made in 1878 (after Pogson and Smith, 1893: 147).

Number and Date.	Magnitude.	Mean Right Ascension 1880.			No. of Wires.	Mean Polar Distance 1880.			Observer.	Number and Date.	Magnitude.	Mean Right Ascension 1880.			No. of Wires.	Mean Polar Distance 1880.			Observer.
		h.	m.	s.		°	'	"				h.	m.	s.		°	'	"	
Oct. 5	...	21	25	14.44	...	96	5	53.8	M	Oct. 14	...	21	47	36.15	...	64	38	16.4	M
6	...	25	14.48	...	5	52.2	M	21	...	47	36.13	...	38	17.0	M				
9	...	25	14.44	...	5	52.0	M	25	...	47	36.08	...	38	15.4	M				
20	...	25	14.33	...	5	52.1	M	26	...	47	36.25	...	38	18.1	M				
26	...	25	14.42	...	5	52.7	M	Nov. 5	...	47	36.07	...	38	19.0	R				
Nov. 1	...	25	14.34	...	5	55.1	R												
542 <i>8 Pegasi ε</i>										547 <i>W. B. E. XXI. 1334.</i>									
Oct. 2	...	21	38	17.49	...	80	40	26.8	M	Oct. 13	8.0	21	59	12.08	...	98	16	38.8	M
21	...	38	17.52	...	40	25.1	M	16	...	59	11.98	...	16	38.3	M				
25	...	38	17.54	...	40	27.0	M	25	...	59	11.85	...	16	39.5	M				
26	...	38	17.42	...	40	28.5	M	26	...	59	12.04	...	16	40.3	M				
Nov. 1	...	38	17.58	...	40	27.1	R	29	8.0	59	11.98	...	16	39.1	M				
2	...	38	17.54	...	40	26.8	R												
543 <i>78 Draconis.</i>										548 <i>34 Aquarii α</i>									
Sep. 16	...	21	41	35.97	...	18	13	47.8	R	Oct. 3	...	21	59	37.11	...	90	54	5.2	M
18	...	41	36.00	...	13	46.6	R	6	...	59	37.07	...	54	6.5	M				
22	...	41	35.97	...	13	47.3	R	8	...	59	37.13	...	54	5.7	M				
24	...	41	36.01	...	13	46.1	R	Nov. 8	...	59	37.06	...	54	5.3	R				
30	...	41	35.81	...	13	47.5	R												
Oct. 1	...	41	36.18	...	13	45.3	M												
544 <i>10 Cephei ν</i>										549 <i>17 Cephei ξ—2nd.</i>									
Sep. 15	...	21	41	59.00	...	29	25	56.4	R	Sep. 17	...	23	0	19.00	...	25	57	21.3	R
17	...	41	59.05	...	25	57.2	R	18	...	0	18.87	...	57	21.7	R				
21	...	41	58.96	...	25	57.7	R	21	...	0	18.79	...	57	21.6	R				
23	...	41	59.12	...	25	57.2	R	22	...	0	18.97	...	57	20.4	R				
										23	...	0	19.21	...	57	21.2	R		
545 <i>U Cephei, Var. 5.</i>										550 <i>Anon.</i>									
Oct. 2	...	21	44	53.05	...	20	24	19.0	M	Oct. 21	9.5	22	1	43.05	...	98	31	57.0	M
4	6.5	44	53.36	...	24	19.1	M	27	9.5	1	44.12	...	31	56.3	M				
5	6.8	44	53.69	...	24	20.6	M	28	9.5	1	44.08	...	31	56.8	M				
6	7.0	44	53.84	...	24	18.9	M	30	9.5	1	43.93	...	31	58.3	M				
7	7.0	44	53.60	...	24	19.2	M	Nov. 2	9.6	1	44.02	5	31	57.6	R				
546 <i>16 Pegasi.</i>										551 <i>15 Piscis Australis.</i>									
Sep. 17	...	21	47	36.06	...	64	38	18.6	R	Sep. 6	5.6	22	3	6.58	...	123	8	14.0	R
22	...	47	36.10	...	38	16.6	R	15	5.6	3	6.80	...	8	12.7	R				
23	...	47	36.16	...	38	16.4	R												
Oct. 8	...	47	36.13	...	38	18.6	M												

Figure 6: Madras Observatory observations of U Cephei made in 1880 (after Pogson and Smith, 1894: 42).

In Europe, excluding Russia, there now exist fifty-four public and ten private Observatories spread over an area of less than two million square miles. In India with a surface of one and half million miles we have but one, that one wholly supported by the State ... I recommend no more than that a modest but thorough place of instruction and study should be founded where theoretical knowledge can be united to actual practical work ... Such places exist in hundreds in Europe, but nowhere is

the need for them greater than in India. Not much money, a little zeal, a little steadfastness of purpose, wed these to a regard for science, and soon would the metropolis of Southern India be graced with an Institution which would be an honor to the country. (Cited in Obituary, 1881: 182).

S.M.R. Ansari (1985) has stated that observatories like the ones at Madras, Bombay and Calcutta remain-

ed in effect "... alien outposts of a foreign science ..." and were a kind of 'island' which solely served British science. As we have seen, Ragoonatha Charry was one person who strove constantly to spread the benefit of these Observatories to the local public and not let them remain as 'islands'. Whenever a major celestial event occurred, such as a total solar eclipse or a transit of Venus, he took the opportunity to publish pamphlets, not only in English but also in various local languages, explaining the phenomena and how native astronomical methods and calculations could be improved with better data. In his pamphlet on the 1874 transit of Venus he states:

It is written principally for information of such of my countrymen as have not had the advantage of any regular course of scientific reading ... Although the class of phenomena to which the Transit of Venus belongs is mentioned in Hindu treatise on Astronomy, especially of the Sidhanta Siromani, yet the Sidhantis or Hindu astronomers are really not familiar with the nature of this particular occurrence and cannot predict it with even a rough approach to accuracy, happening as it does at such strange and rare intervals. (Ragoonatha Charry, 1874).

Ragoonatha Charry wrote the English version in the style of a dialogue as he was accustomed to discussing astronomical facts and methods orally with Hindu professors. He intentionally wrote the other language versions, Sanskrit, Canarese, Tamil, Telugu, Urdu, Malayalam and Marathi in a different style, explaining that in order to cater for the native public "... it was found convenient to vary this arrangement." (Obituary, 1881: 181).

The 'cherished object' of Ragoonatha Charry's life was to publish a two-volume monograph

... upon Astronomy which should embody the corrections, equations and formulae established by European [modern] research together with what is proper to retain from our own works, and thus to construct a manual accessible to Hindu astronomers ... (ibid.).

Regrettably, ill health took him away on 5 February 1880 (Obituary, 1881), before he could complete this work, but he maintains a notable place in the history of Indian astronomy.

6 NOTES

1. We should point out, however, that E.B. Powell (1861), an avid amateur astronomer and the Director General of Public Instruction in Madras, made observations of the enigmatic variable, η Argus (now η Carinae), from 1853. Taylor (1832) and Jacob (1847; 1849) also observed η Argus from Madras and Pune respectively.
2. Variations on the spelling of elements of Chintamani Ragoonatha Charry's name include: Chintamanny (Obituary, 1881: 180), Ragoonathachary (Ananthasubramanian, 1991: 102), Raghunathachari (Salwi, 1988: 190), Charey (Ragoonatha Charey, 1859), Chary (Ragoonatha Chary, 1868b) and Cintamani Raghunatha Acarya (Dikshit, 1981: 181). We used the spelling of his name as it appears in his signature.
3. Nowhere do Ragoonatha Charry or his contemporary colleagues at the Madras Observatory discuss the nature of these instruments, so regrettably we have no information at all about them.
4. This instrument was modelled on one designed by George Biddell Airy for the Royal Observatory at Greenwich (see Satterthwaite, 2001).
5. This catalogue was prepared by Charles Michie Smith, and published after Pogson's death.

7 ACKNOWLEDGEMENTS

The authors would like to thank Dr A.V. Raveendran for his advice and help. We appreciate the generosity of Ms Cherry Armstrong in making available a collection of photographs of N.R. Pogson, her great, great, grand-father and his family to us and donating them to IIA Archives. We also would like to thankfully acknowledge the help received from the Tamilnadu Archives and the Theosophical Society in Chennai. We appreciate greatly the help received from Wayne Orchiston in the preparation of this paper.

Finally we wish to thank the Department of Science and Technology (DST) of the Government of India for financial assistance through project SR/S2/HEP-26/06, and the referees for their helpful comments.

8 REFERENCES

- Allen, C.W., 1973. *Astrophysical Quantities*. London, The Athlone Press.
- Allen, D.A., Hall, P.J., Norris, R.P., Troup, E.R., Wark, R.M., and Wright, A.E. 1989. Detection of new southern SiO maser sources associated with Mira and symbiotic stars. *Monthly Notices of the Royal Astronomical Society*, 236, 363-374.
- Ananthasubramanian, C.K., 1991. The Madras Observatory, 1792-1931. *Journal of the Royal Astronomical Society of Canada*, 85, 97-106.
- Ansari, S.M.R., 1985. Introduction of modern Western astronomy in India during 18-19 centuries. *Indian Journal of History of Science*, 20, 363-402.
- Campbell, L., 1926. Light curve of R Reticuli. *Harvard College Observatory Bulletin*, 841, 9-12.
- Ceraski, W., 1880. Schreiben des Herrn W. Ceraski an den Herausgeber. *Astronomische Nachrichten*, 97, 319.
- Chandler, S.C., 1890. Supplement to the first edition of the catalogue of variable stars. *Astronomical Journal*, 9, 185-187.
- Chandler, S.C., 1896. Third catalogue of variable stars. *Astronomical Journal*, 16, 145-172.
- Clerke A., 1903. *Problems in Astrophysics*. London, Adam & Charles Black.
- Dikshit, S.B., 1981. *History of Indian Astronomy. Part II. History of Astronomy During the Siddhantic and Modern Periods*. Delhi, Government of India Press (English translation by R.V. Vaidya of the 1896 original, *Bharatiya Jyotish Sastra*).
- Hoffleit, D., 1985. Was Harlow Shapley right about V Cephei? *Journal of American Association of Variable Star Observers*, 14, 64-66.
- Hogg H.S., 1984. Variable stars. In Gingerich, O. (ed.). *The General History of Astronomy. Volume 4. Astrophysics and Twentieth-Century Astronomy to 1950: Part A*. Cambridge, Cambridge University Press. Pp. 73-89.
- Jacob, W.S., 1847. Catalogue of double stars observed at Poonah in 1845-46. *Memoirs of the Royal Astronomical Society*, 26, 311-322.
- Jacob, W.S., 1849. Catalogue of double stars, deduced from observations made at Poonah from November 1845 to February 1848. *Memoirs of the Royal Astronomical Society*, 27, 79-91.
- Kochhar, R.K., 1985. Madras Observatory – buildings and instruments. *Bulletin of the Astronomical Society of India*, 13, 287-302.

- Kochhar, R.K., 1991. The growth of modern astronomy in India, 1651-1960. *Vistas in Astronomy*, 34, 69-105.
- Kochhar, R.K., 1992. Science in British India. 1. Colonial tool. *Current Science*, 63, 689-694.
- Kochhar, R.K., 1993. Science in British India. 2. Indian response. *Current Science*, 64, 55-62.
- Madras Almanac*. Madras, Asylum Press (1867).
- Madras Almanac*. Madras, Asylum Press (1880).
- Milton, R.E., Williams, D.B., and Hoffleit, D., 1988. Photoelectric photometry and further discussions of V Cephei. *Journal of American Association of Variable Star Observers*, 17, 137-140.
- Obituary: Chintamanny Ragoonatha Chary. *Monthly Notices of the Royal Astronomical Society*, 41, 180-183 (1881).
- Orchiston, W., 2000. John Tebbutt of Windsor, New South Wales: pioneer Southern Hemisphere variable star observer. *Irish Astronomical Journal*, 27, 47-54.
- Orchiston, W., Chen, K.-Y., Lee, E.-H., and Ahn, Y.-S., 2006. British observations of the 1868 total solar eclipse from Guntoor, India. In Chen, K.-Y., Orchiston, W., Soonthornthum, B., and Strom, R. (eds.). *Proceedings of the Fifth International Conference on Oriental Astronomy*. Chiang Mai, Chiang Mai University. Pp. 23-34.
- Pogson, N.R., 1861a. *Proceedings of Madras Government Public Department*. Madras, Madras Observatory.
- Pogson, N.R., 1861b. Discovery of a new planet 'Asia', *Monthly Notices of the Royal Astronomical Society*, 21, 219.
- Pogson, N.R., 1861c. Ephemeris of the long period variable stars for 1862. *Monthly Notices of the Royal Astronomical Society*, 21, 155-157.
- Pogson, N.R., 1867. *Administrative Report of Government Observatory*. Madras, Madras Observatory.
- Pogson, N.R., 1871a. Letter to the Acting Chief Secretary of the Madras Government dated 3 July. Madras Observatory, Tamilnadu Archives.
- Pogson, N.R., 1871b. Letter to R.S. Ellis dated 16 August. Madras Observatory, Tamilnadu Archives.
- Pogson, N.R., 1872a. Observations made during the eclipse of June 6, 1872. *Monthly Notices of the Royal Astronomical Society*, 32, 330-331.
- Pogson, N.R., 1872b. Observing log of the 3 November 1872 occultation of Venus. Madras Observatory (Indian Institute of Astrophysics Archives).
- Pogson, N.R., 1878. *Madras Observatory Annual Report*. Madras, Madras Observatory (Indian Institute of Astrophysics Archives).
- Pogson, N.R., 1879. *Madras Observatory Annual Report*. Madras, Madras Observatory (Indian Institute of Astrophysics Archives).
- Pogson, N.R., 1887. *Results of Observations of the Fixed Stars Made with the Meridian Circle at the Government Observatory, Madras, in the Years 1865, 1866, 1867*. Madras, Madras Observatory (Volume 2).
- Pogson, N.R., and Smith, C.M., 1893. *Results of Observations of the Fixed Stars Made with the Meridian Circle at the Government Observatory, Madras, in the Years 1877, 1878, 1879*. Madras, Madras Observatory (Volume 6).
- Pogson, N.R., and Smith, C.M., 1894. *Results of Observations of the Fixed Stars Made with the Meridian Circle at the Government Observatory, Madras, in the Years 1880, 1818, 1882*. Madras, Madras Observatory (Volume 7).
- Pogson, N.R., Brook, C.L., and Turner, H.H., 1908. Observations of thirty-one variable stars by the late N.R. Pogson. *Memoirs of the Royal Astronomical Society*, 58.
- Powell, E.B., 1861. Variations in the light of η Argus, observed at Madras from 1853 to 1861. *Monthly Notices of the Royal Astronomical Society*, 22, 47-48.
- Ragoonathachary, C., 1871. On the total eclipse of the Sun, on December the 11th, 1871, as visible in Madras Presidency. *Monthly Notices of the Royal Astronomical Society*, 31, 137-146.
- Ragoonatha Charey, C., 1859. On the determination of personal equation by observations of the projected image of the Sun. *Monthly Notices of the Royal Astronomical Society*, 19, 337-338.
- Ragoonatha Chary, C., 1868a. *Madras Almanac*. Madras, Asylum Press.
- Ragoonatha Chary, C., 1868b. Occultations visible in the month of August, 1868, at Madras, and along the shadow path of the total eclipse of the Sun in India. *Monthly Notices of the Royal Astronomical Society*, 28, 193-196.
- Ragoonatha Chary, C., 1874. *Transit of Venus*. Madras (Indian Institute of Astrophysics Archives).
- Salwi, D.M., 1988. Madras Observatory: a forgotten page in astronomy. *Journal of the British Astronomical Association*, 98, 189-193.
- Satterthwaite, G.E., 2001. Airy's transit circle. *Journal of Astronomical History and Heritage*, 4, 115-141.
- Sen, S.N., 1989. Madras meridian circle observation of fixed stars during 1862 to 1887. *Indian Journal of History of Science*, 24, 257-283.
- Shapley, M.B., 1916. The period of U Cephei. *The Astrophysical Journal* 44, 51-58.
- Taylor, T.G., 1832. *Results of Astronomical Observations for the Year 1831*. Madras, Madras Observatory.
- Taylor, T.G., 1832-1848. *Madras Astronomical Observations for the Year 1831 (Vol. I) to 1847 (Vol. VIII)*. Madras, Madras Observatory.
- Venkateswaran, T.V., 2009. Chinthamani Ragoonathachary and secularisation of time during the late nineteenth century Madras Presidency. *Proceedings of epISTEME*. 3, 25-32.
- Webbink, R.F., 1978. Probable identification of the recurrent nova U Scorpii at minimum. *Publications of the Astronomical Society of the Pacific*, 90, 57-59.
- Yendell, P.S., 1903. On the light-variations of 320 U Cephei. *The Astronomical Journal*, 23, 213-219.

N. Kameswara Rao is a Visiting Professor at the Indian Institute of Astrophysics (IIA) in Bangalore. He retired from the IIA as Senior Professor of Astrophysics in 2007. His main research interests are hydrogen deficient stars, R CrB stars, observational studies of stellar evolution and circumstellar dust, and the history of observational astronomy in India. He is also presently the PI of a DST project regarding development of observational astronomy in India. He is a member of the International Astronomical Union and the Astronomical Society of India.

Dr A. Vagiswari is presently a co-PI of the DST project on the history of observational astronomy in India. She retired from the IIA as its Librarian and Archivist. She is interested in tracing the history of the IIA and its predecessors, the Madras and Kodaikanal Observatories. She also has interest in carnatic music.

M. Priya Thakur is a project assistant at the IIA. She recently submitted her Ph.D thesis to the University of Mysore in Ancient History and Archaeology. Her research interests lie mainly in archaeo-astronomical studies, archaeology and epigraphy. She has published more than ten research papers. Priya is associated with the Ancient Sciences and Archaeological Society of India, and the Epigraphical Society of India.

Dr Christina Birdie is the Librarian of the IIA. Her main responsibilities include the management of the library and the archives of the Institute. She is also interested in collecting and preserving the materials pertaining to the history of the Institute. Christina is one of the members of the IAU Division XII Libraries Working Group.