# NEW TELESCOPES IN INDIA*

J. C. BHATTACHARYYA
*Indian Institute of Astrophysics, Bangalore, India*

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**Abstract.** The review covers the description and present status of the two optical/infrared telescopes designed and presently near fabrication in India. The 234 cm aperture optical telescope expected to be installed at Kavalur shortly has several interesting features in its control and data acquisition systems. Design features of the 122 cm Infrared Astronomical Telescope expected to be completed next year are described. The review also covers the Ooty Synthesis Radio Telescope and the Gauribidanur Low Frequency Array operating at 327 and 34 MHz, respectively, and a 10 m aperture millimeter wave telescope being built in Bangalore. Plans and preparations for still bigger systems for observations in different bands of Electromagnetic spectra are also briefly described.

For the major part of the last hundred years, observational astronomy in India was limited to the activities of two observatories at Kodaikanal and Hyderabad. But after independence in 1947, a determined thrust has been put to build up new astronomical observatories, where front line research will be possible. There have also been advances in the field of astronomical observations with balloons, rockets, and satellite-borne instruments, probing the portions of electromagnetic spectra inaccessible from the ground. The present report covers only the ground based installations, carrying out observations in those bands which reach the Earth's surface through several transparent windows in the atmosphere.

The locations of the major installations are shown in Figure 1. Concentration is in the southern part of India, partly because almost the entire sky is accessible from these locations. The southernmost location is in Kodaikanal ($+10°14'$), where optical observations were started at the turn of the century‡ and the first radio observations of the Sun from India commenced in 1952†. The observatory now concentrates on observations of the Sun and the solar system in optical bands. A 'Solar Terrestrial Physics' unit is also located here which carries out regular observations of the geomagnetic and ionospheric variations connected with solar events.

Moving northwards, the next major installation is at Ooty ($+11°23'$) where the large steerable parabolic cylinder carries on investigations of the radio sources in the meter wavelength region. This telescope was totally designed and built in India and was commissioned in 1970. The instrument operates nominally at 327 MHz, and was originally designed for radio source studies by the Lunar Occultation technique. Recently this has been linked up with seven more smaller dishes and can now function as a synthesis telescope (Swarup, 1984).

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‡ Report of the Kodaikanal and Madras Observatories for 1900–1901.
† Annual Report of Kodaikanal Observatory for the year 1952.

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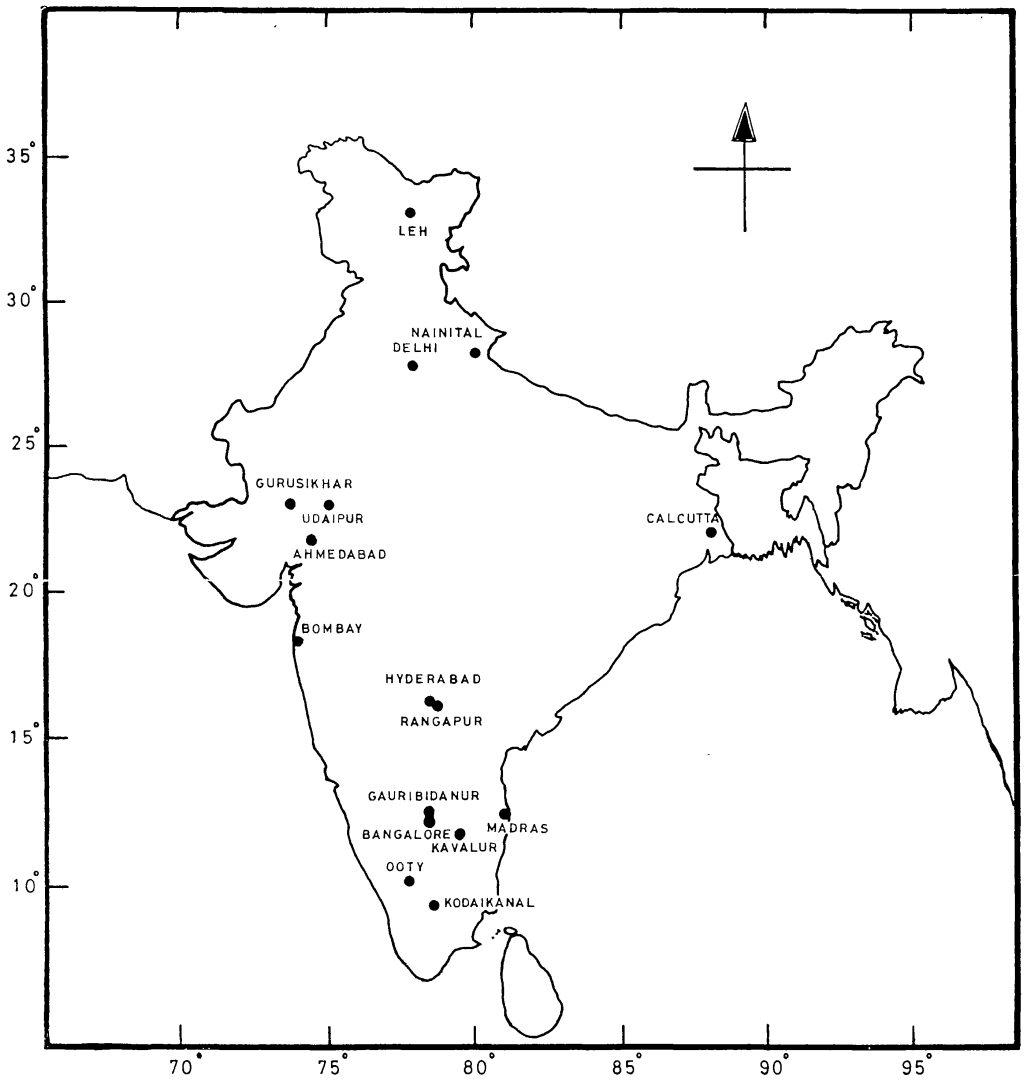


Fig. 1. Locations of the major installations.

Still further north, we come across Kavalur Observatory ($+12°34'$) which is the major optical observatory in India. The largest telescope at the moment is 102 cm Zeiss Ritchey–Chrétien reflector; there are two more, locally made, 75 and 38 cm reflector telescopes. In an adjacent building, installation of a 234 cm reflecting telescope has just started.

This telescope is of indigenous design and manufacture. Figure 2 shows an artist's sketch of the general arrangements of the optical elements and mounting. Equatorially mounted, with a 6 m horse-shoe as its north bearing, this is driven by large spur gears around both polar and declination axes. The driving motor set consists of two torque motors in opposition to reduce the gear backlash. Twenty bit absolute position encoders feed back position information to a set of microprocessors which control the driving rate with the help of a precision clock. A VAX 11/780 computer will exercise supervisory

control over the movements, and also regulate the collection and on-line processing of data. Elaborate peripherals have been provided to receive data from two-dimensional detector arrays and process the same for a variety of experiments.

The optics has been ground and figured at the optical laboratory of the Indian Institute of Astrophysics (IIA) at Bangalore, the organization which controls both the Kodaikanal and Kavalur observatories. The optical arrangement will provide a $f/3.25$ prime, $f/13$ Cassegrain, and $f/43.25$ Coudé foci. It will immediately operate in the prime focus mode with a Wynne corrector for photography, and a photometer and image tube spectrograph. Cassegrain and Coudé instrumentation will follow in due course.

In Bangalore, besides the IIA, we have another institution, the Raman Research Institute (RRI) which has undertaken a project of constructing a millimeter wave telescope. A 10.4 cm dish has been fabricated and is presently under installation. The equipment will later be moved to a nearby location after the initial trials are over. The complete antenna and the receiver system are of indigenous design and fabrication.

100 km north of Bangalore, we come across an extended array of dipoles set up for studies of celestial radio sources in the decameter region. The array consists of 1000 dipoles and stretches in the form of a T, 1400 m in the E–W direction and 450 m in N–S direction. Studies of solar decametric bursts, and mapping of selected H II regions and extended sources in the sky have been carried out with this equipment (Sastry, 1983). This is a joint venture between the two institutions in Bangalore, IIA and RRI; several important modifications are now being carried out to refine the capabilities of the telescope.

A scheme has just been submitted for the construction of a Giant Meterwave Radio Telescope in this region. This is a very ambitious project, and when completed, will be composed of 27 large dishes located in the form of a Y in an area of 30 km across. If approved, work will start immediately, and we may have the telescope operational in the mid-nineties.

Still further north, we have the old Nizamiah Observatory at Hyderabad which is being moved to a new location in the University campus outside the city. But the observatory's main installations are at a site 60 km away at Japal–Rangapur ($+17°06'$), where a 122 cm reflector, with Nasmyth focus is regularly carrying observational programmes in variable stars. The old 10-inch astrograph which obtained all the plates of the 'Carte du Ciel' programme in the early part of this century, is also located there (Sanwal, 1975).

Following our northerly course, we will now come across two observatories almost at the same latitude in the western part of India. The first one is at Udaipur ($+24°35'$) where on an island in the midst of a lake, a small solar observatory was established in 1974. The instrument, presently in use is a solar telescope and monochromator mounted on a 3.5 m spar (Bhatnagar *et al.*, 1979). Because of the surrounding body of water, the seeing throughout the day remains quite good.

The other observatory is near the hill town of Mount Abu ($+24°36'$), a peak called Gurushikhar. It is a new site where a 1.22 m aperture telescope for IR observations will be installed by end of 1985. The design of the system has been drawn up and frozen.

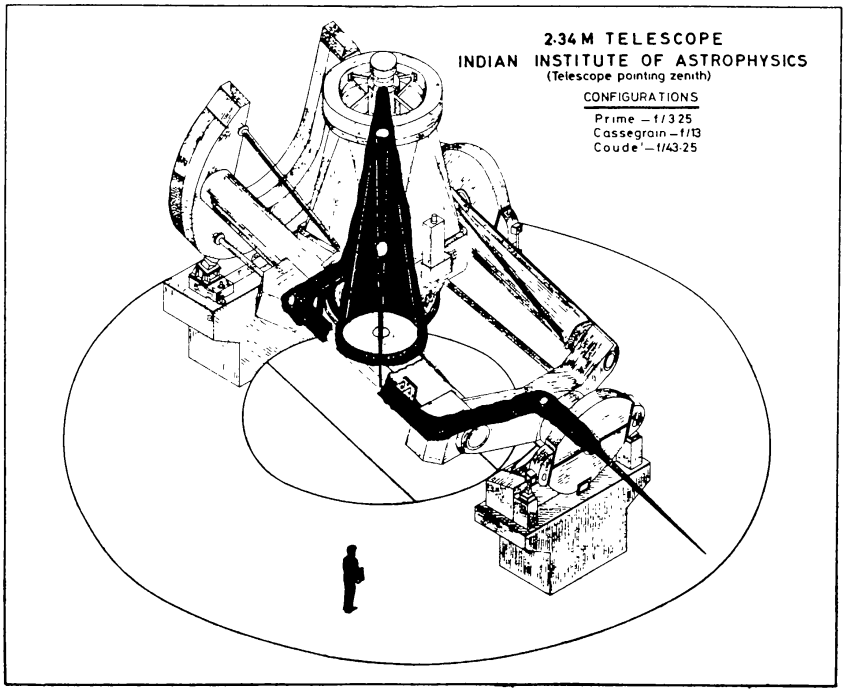


Fig. 2. General arrangements of the optical elements and mounting.

The civil works at the site are nearing completion, the mechanical mount fabrication is about to start and the optical works are well on their way to completion. This is an effort by several institutions in India and it is expected that the telescope will be completed in time.

The next optical observatory in the northern sector is in Nainital ($+29°22'$), in the foothills of the great Himalayas. The observatory was established in 1955 and now has several functioning optical telescopes. The largest one is a Zeiss 104 cm reflector, a twin of the instrument at Kavalur (Pande, 1979). There are several telescopes of the half-meter class in this observatory.

The observatory has proposed a very ambitious plan of acquiring a 4 m telescope. The details of the project are not known yet; but it is understood that they propose indigenous construction along the lines of the recently constructed 2.34 m telescope at Kavalur. To make the fabrication plan conform to existing manufacturing capabilities in the country, several changes in the design would, however, be necessary. These are now being vigorously pursued by the scientists of this observatory. Testing of several sites are going on in the nearby hills before deciding on the final location of the instrument.

Further up north, a new high altitude site is being tested thoroughly in the Ladakh region of Kashmir. The experiment will consist of the detailed recording of meteorological parameters and conducting a series of micrometeorological, seeing and transparency observations. A 50 cm aperture optical telescope has already been moved up there and parts of the photometric programmes of several observatories in India are

being carried out. Humidity in that region is very low; the total precipitable water above the site is often less than 1–2 mm; the underlying idea is to locate a suitably-sized IR telescope here in future.

This sums up the current efforts in creating new major groundbased observational facilities in India. There are concentrated efforts for installing half-meter class optical telescopes in several universities where astronomy or astrophysics is being taught. The present estimate of the number of such universities is about twenty in the entire country. A totally indigenous design has been drawn up and a prototype constructed by the IIA in Bangalore. The first telescope is being installed in the campus of the Indian Institute of Science, Bangalore. A 60 cm aperture Zeiss telescope has been acquired by the Panjabi University, Patiala, which is currently in the process of installation. Several old educational institutions in the country also have small working telescopes of 15 to 25 cm aperture. Although extensively used in the past, they are now lying unused. A vigorous effort to bring them up into work is being made by the astronomical societies in the country.

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