RADIO ASTRONOMY CENTRE, OOTACAMUND

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This report describes work being carried out in the field of radio astronomy at the Tata Institute of Fundamental Research using a large radio telescope located at Ootacamund (latitude 11° 22′ 50″ N, longitude 76° 40′ 02″ E, altitude 2150 m).

INSTRUMENTS :

The Ooty radio telescope consists of a 529 m long and 30 m wide parabolic cylindrical reflector. Its surface is made of 1100 stainless steel wires, supported by 24 steel frames, each 30 m wide. In order to make its axis of rotation parallel to that of the earth, the parabolic cylinder has been placed on a hill that has a slope of 11° 23′ in the north-south direction. Thus a radio source can be tracked in hour angle for 9½ hours per day by a simple mechanical rotation of the cylindrical reflector. The beams of the telescope are steered in declination from + 36° to —36° using accurately controlled phase-shifters and delay lines. The radio telescope operates at 327 MHz with a receiver bandwidth of about 4 MHz. It provides an effective collecting area of about 8000 m^2, and is one of the largest radio telescopes in the world. Its construction was started in 1966 and completed in 1970. This telescope has been designed and fabricated fully in India; the know-how thus acquired has been used extensively for design and construction of antennas required by various agencies in India for communication and radar systems.

An aperture-synthesis type interferometer is being set up, which consists of the Ooty radio telescope and two parabolic dishes of 13.5 m diameter each, located about 600 m apart in the north-south direction and at a distance of about 3.5 km to the west of the Ooty radio telescope. Observations with the interferometer using one of the two 13.5 m dishes and the Ooty radio telescope will be started within a few months.

A line filter receiver is being constructed to search for the deuterium line and the recombination lines near 327 MHz. Development work for simultaneous operation of the Ooty radio telescope at 109 MHz has also been started.

PROGRAMMES AND RESULTS OBTAINED :

(a) **Lunar Occultation Observations:**— The Ooty radio telescope was designed mainly for lunar occultation observations of radio sources. The methods of occulation provides a resolution of a few arc seconds or better, and is particularly valuable for observations at metre wavelengths because such high resolution cannot be achieved in practice at these wavelengths using interferometers. Thus the Ooty observations become complementary to the high resolution observations being made at centimetre wavelengths with the recent supersynthesis interferometers at Cambridge, Westerbork and Green Bank. Further, in view of its large collecting area, the Ooty radio telescope enables occultation observations of weak and consequently very distant extragalactic radio sources, for which detailed information is not so far available.

Since 1970, occultations of over 600 radio sources, most of them having flux densities of about 0.5 to 2 flux units (one f.u. = 10^{-26} Watts m^{-2} Hz^{-1}), have been observed. Analysis has been completed for about 300 radio sources, giving details of their structure with a resolution of about 1 to 10 arc seconds. About 17 per cent of these objects have been identified with galaxies and 14 per cent with quasars. Most of these 300 sources have been resolved. Occultation observations of strong radio sources, including several 3C sources, have shown the presence of considerable fine structure in these objects even at the metre wavelengths.

High frequency studies of the Ooty occultation sources are being carried out using the 3 element interferometer of the National Radio Astronomy Observatory, U.S.A.

It is found that half of the Ooty occultation sources have an angular size less than about 8 arc seconds ; the corresponding number for 3C radio sources, that have about 12 times larger flux density, is 25 arc seconds. This indicates that statistically Ooty occultation sources are located much farther away compared to 3C radio sources. Investigations about the cosmological implications of the data are in progress.

High resolution studies of the galactic centre source, Sagittarius A, have been made. A new extended component $\sim 10 \times 4$ arc minutes in size was found near the centre of our Galaxy. Electron temperature and other physical parameters have been derived for several thermal sources located near the galactic centre. A supernova remnant has been found near the H II region G 1.1-0.1. High resolution observations of the H II region M8 indicate the presence of an extragalactic radio source in that direction.

(b) **Pulsars:**—Three new pulsars have been found including a pulsar with a period of about 2 seconds which has the largest duty cycle, $\sim$ 25 per cent of the period, of the known pulsars. In contrast, most pulsars have a duty cycle of about 5 per cent. This observation puts constraints on various models for the radio emission from pulsars. In order to determine the velocity of pulsars or of the interstellar medium, simultaneous observations of 7 pulsars were made in 1971 at 327 MHz using the Parkes radio telescope in Australia and the Ooty radio telescope in India. Using the large antenna of the Lebedev Physical Institute, U.S.S.R., operating at about 100 MHz and the Ooty radio telescope operating at 327 MHz, simultaneous observations of several pulsars were made in 1973. The observations were undertaken to study the dependence of widths and shapes of the same pulses on frequency. The data are being analyzed. Programmes have been undertaken recently for studying the fine structure of pulsars and also for studying the variations in their intensity caused by intrinsic modulations and interstellar scintillations.

(c) **Interplanetary Scintillations:**— A survey of about 400 radio sources in the southern sky has been made for interplanetary scintillations (IPS). This study has given information on the fraction of the flux-density of each source that arises from components with sizes of about 0.1 to 0.5 arc second. In addition, two dimensional structures have been obtained for a number of sources by studying them on various days when the source is scanned by the solar wind at different position angles. From systematic IPS observations of several strong sources made at 327 MHz, it is found that the scale size of interplanetary medium does not change much with distance from the sun, at least in the region outside about 0.25 a.u. from the solar disc in contrast to the results by earlier workers. An attempt is being made to study the theory of strong scattering close to the sun which is little understood at present.

During the occultation of a scintillating (IPS) source PKS 2025-15 by the comet Kohoutek (1973f), on January 5, 1974, random intensity variations with a time scale of $\sim$10 sec were observed ; these are the first observations of scattering or scintillations of a radio source caused by a comet and open up possibilities of studying electron density irregularities in the tails of comets.

(d) **Flare Stars**:—During October and November 1973, radio observations of flare stars in the Pleiades were made at Ooty. Simultaneously, optical observations were made at Kavalur, India and Byurakan, U.S.S.R.

PUBLICATIONS :

Since the commissioning of the radio telescope in 1970, 29 papers have been published.

ACADEMIC STAFF AND GRADUATE STUDENTS :

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