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Reports from astronomical centres

Indian Institute of Astrophysics and Raman Research Institute

The decameter-wave radio telescope

The large decametre-wave radio telescope, constructed jointly by Indian Institute of Astrophysics and Raman Research Institute, is located near Gauribidanur, Kolar district, Karnataka (longtitude 77° 26′ 07″ and latitude 13° 36′ 12″ N). It is a T shaped array of one thousand broad-band dipoles, 640 in the east-west arm and 360 in the south arm. All dipoles accept east-west polarization. A full reflecting screen (area $\approx$ 60,000 m^2) is mounted 1.5 m below the dipoles. The entire structure is supported on a grid of 3500 wooden poles of varying heights up to 14 m to compensate for the terrain. In the east-west arm, the elements are arranged in four rows. Each row has ten groups of sixteen broad band dipoles. The rows are spaced 5 m apart and each group of sixteen has its own feeder system to permit phasing in the north-south direction. To preserve the bandwidth of the system a binary branching feeder network is used throughout. The north-south arm consists of 90 rows spaced 5 m apart, each with 4 broadband dipoles. The four dipoles are coupled together in a branched feeder system and each row is connected into the main north-south feeder system. The dimensions of the array are shown in figure 1. A photograph of the east-west array taken from the eastern end is shown in figure 1, 2. In figure 3, a

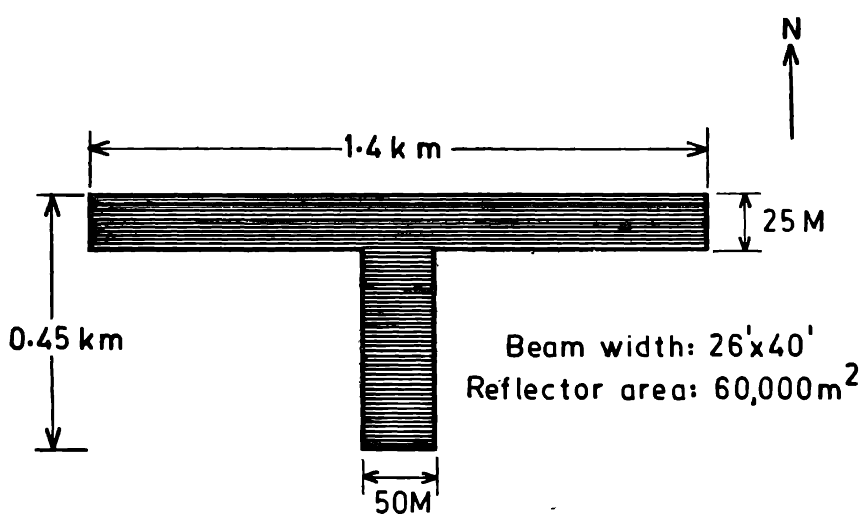

Figure 1. The dimensions of the Gauribidanur arrary.

photograph of the north-south arrary taken from the southern end is shown. The outputs of the east, west and south arms are carried by coaxial cables to the centre of each arm and from there to the main observatory building. The signals are amplified and the sum of the east and west signals is correlated with that of the south arm. In this way a beam of about 26 × 40 arcmin at the zenith is produced at a frequency of 34.5 MHz.

The beam of the south arm can be pointed anywhere within ± 60° of the zenith on the meridian. This is accomplished by adjusting the phase gradient across the aperture using remotely-controlled diode phase shifters. The phase shifters are designed to introduce phase variation in binary steps of 22°.5 from 0° to 360°. The phase variations are achieved by switching calibrated lengths of coaxial cables in the circuit path with the aid of diodes. A special purpose digital control system supplies the switching voltages to set the beam to the required position. The digital control system also cycles the beam through several declinations sequentially. The time required to change the beam from one position to another is of the order of a few milliseconds. The number of declinations through which the beam is cycled can be varied from 1 to 16. The beam of the east-west array can be tilted in hour angle to ± 5° of the meridian. This tilting is also accomplished by remotely-operated diode phase shifters, controlled by another special purpose digital system. It is thus possible to track a source for about 45 minutes around meridian transit.

The receiving system extracts the in-phase (cos) and the quadrature (sin) correlations between the two arms for each one of the beam positions. Predetection bandwidths of 30 and 200 kHz, and postdetection time constants ranging from 1 to 30 s are available. The output of the receiving system is recorded in both analog and digital forms.

The effective area of this instrument is, about 25,000 m^2. At 34.5 MHz, the mean sky brightness is of the order of 10,000 K. So the collecting area is sufficient for the detection of sources whose flux densities are in the range of 10 to 15 Jy (1 Jy = $20^{-26}/W/m^2/Hz$).

Observational results

The radio telescope is being used for the following investigations :

The sun

We have detected weak continuum radiation at decameter wavelengths from the sun when there is no transient burst activity (Sastry *et al.* 1981). The brightness temperature of this radiation is found to be about 10^6 K or less. This value is very close to the coronal temperatures measured by other methods. Therefore, one was able to show that the continuum is due to thermal emission from hot and dense regions in the corona. This is known as the slowly-varying component of the solar radio emission. These are the first maps ever made of the slowly varying component at a decameter wavelength. We are using this radiation as a tool to probe the density and temperature structure of the quiet outer corona, which is not accessible by any other method of observation.

Supernova remnants

The telescope is used to study the structure of extended galactic supernova remnants at decametre wavelengths. Radio maps of the supernova remnants Cygnus loop and

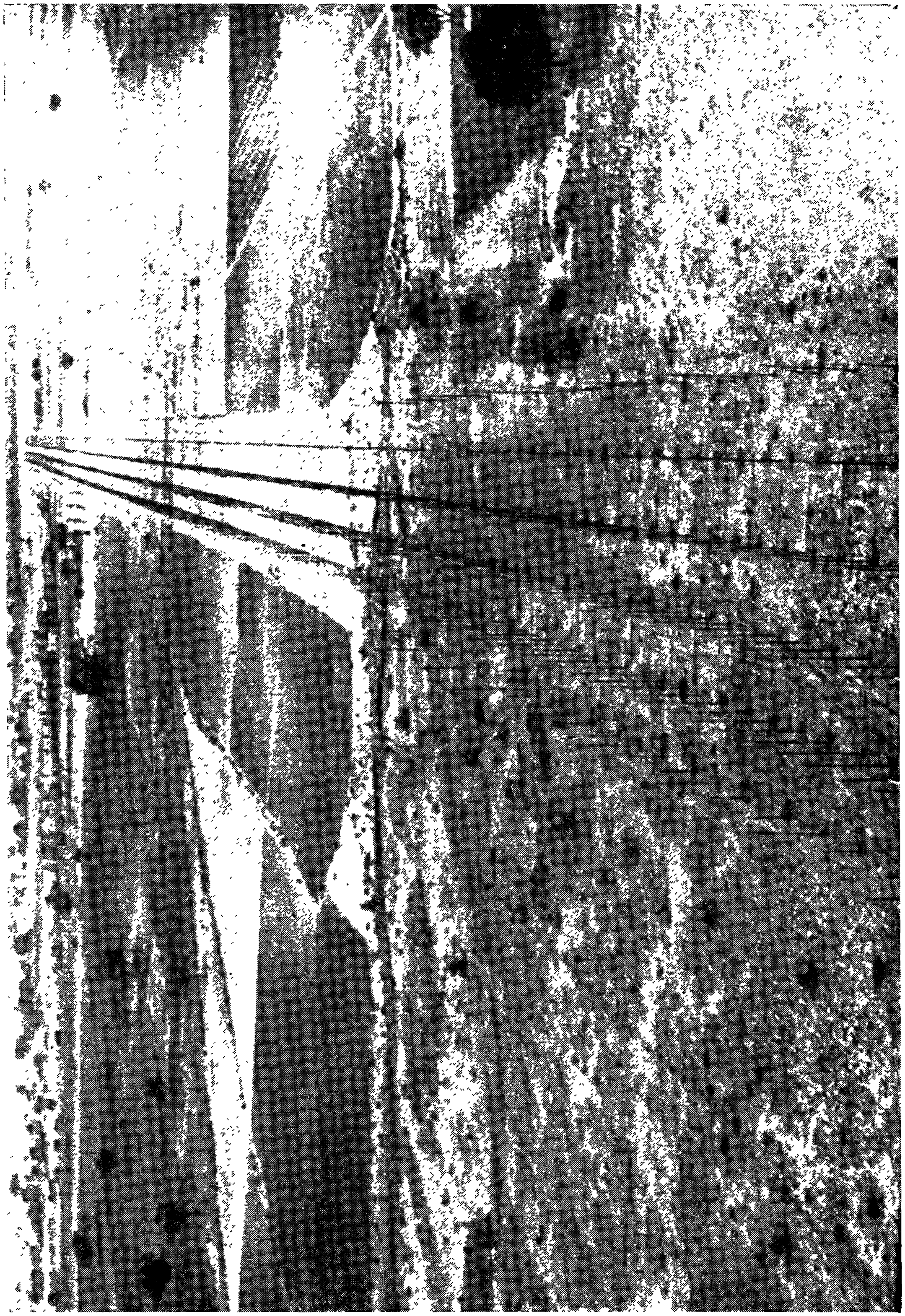

Figure 2. Photograph of the east-west array taken from the eastern end.

Figure 3. Photograph of the north-south array taken from the southern end.

HB9 etc. have been made. We were able to determine the variation of the low frequency spectral indices across these remnants. These results have a bearing on the theories of origin and evolution of radio emission from supernova remnants. We were also able to study the absorption of the low frequency radio flux from some of the remnants in the interstellar medium.

Ionized hydrogen regions

The low frequency radio telescope is the most sensitive detector of ionized hydrogen regions in the galaxy. The temperatures of these regions are $\leqslant$ 10,000 K and so they appear as continuum absorption features against the very bright ($>$ 30,000 K) nonthermal background radio emission from our galaxy. It is possible to measure the electron temperatures of ionized hydrogen regions directly unlike in high frequency measurements where one has to assume LTE conditions in the nebulae to derive the temperatures. We have detected several ionized hydrogen regions in absorption and derived their mean electron kinetic temperatures.

Extragalactic sources

One of the most interesting observations made with the decametre radio telescope in the study of extragalactic radio sources is the mapping of the diffuse radio emission in the Coma cluster of galaxies. This radio emission is believed to originate in the intergalactic medium, due to relativistic electrons and intracluster magnetic fields. Studies of intergalactic matter is of great importance in astrophysics as such matter might provide the gravitational forces necessary to bind together clusters of galaxies, and indeed the entire universe.

List of publications

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