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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

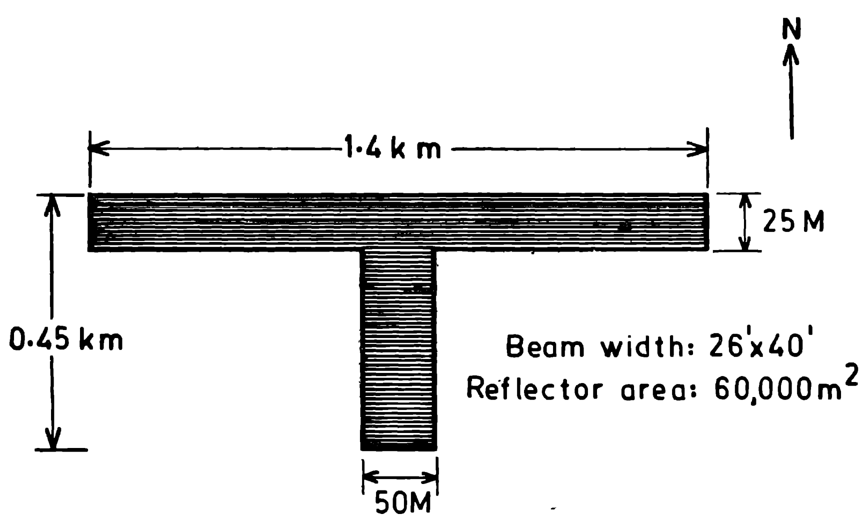

Figure 1. The dimensions of the Gauribidanur arrary.

photograph of the north-south array 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 $\times$ 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 $\pm$ 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 $\pm$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

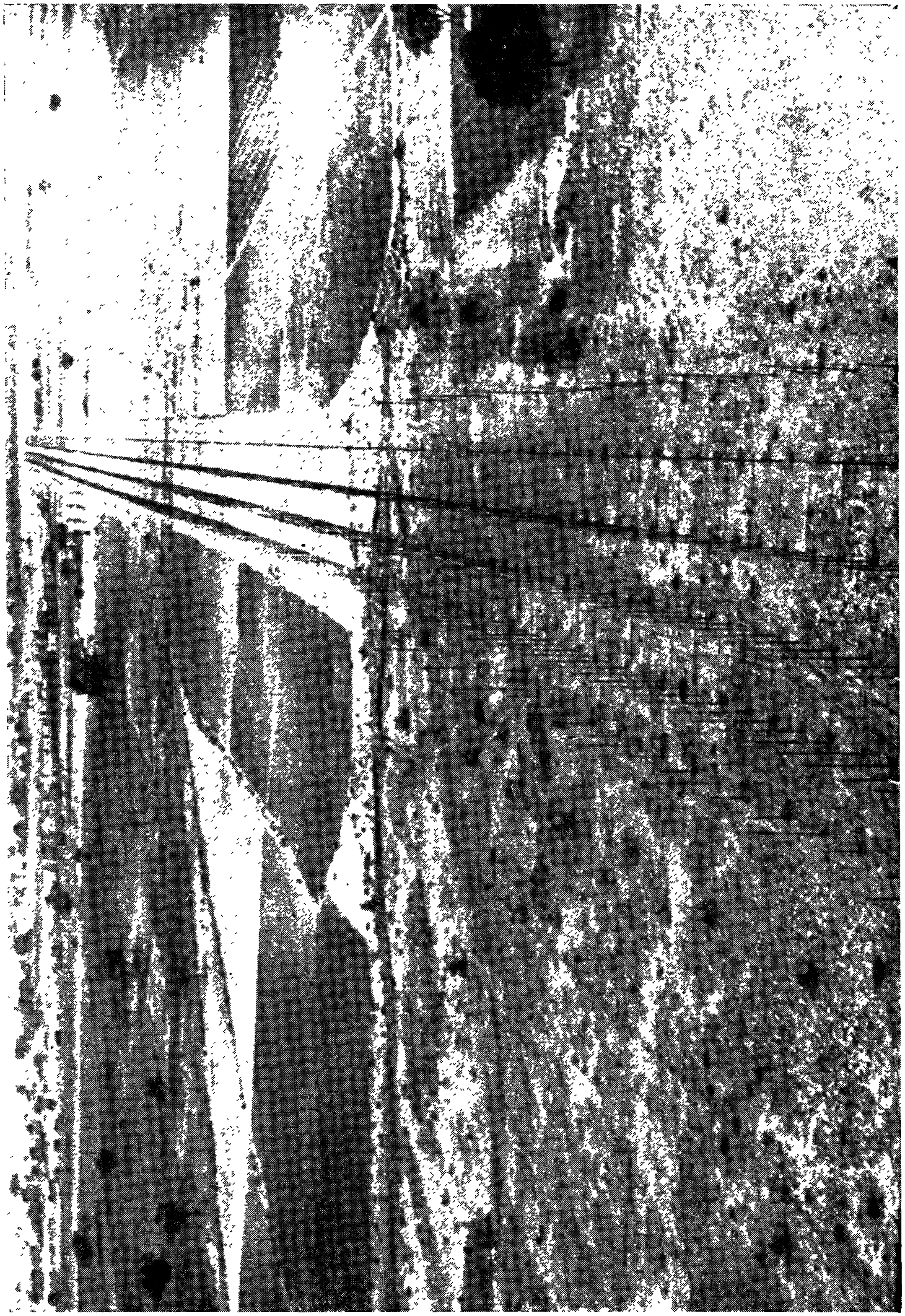

Figure 2. Photograph of the east-west array taken from the eastern end.

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.

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(Ch. V. Sastry)

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NOTES AND NEWS

IAU joint meeting on the violent interstellar medium

The joint meeting of the IAU commissions 34, 40 and 48 on the violent interstellar medium was held on the forenoon of 1982 August 20, at Patras, as the first of a series of joint meetings organized by commission 34 during the 18th general assembly of the IAU. The meeting was well attended.

Following the brief introductory remarks by the chairman, Richard McCray (JILA, Colorado) K. de Boer reviewed the data on the high velocity gas in the galactic disc and halo. Giving a brief historical perspective on the pioneering work in the optical region by Adams, Spitzer, Munch and others, he went on to describe in some detail the wealth of information obtained in UV by *Copernicus* and IUE. This included the observations of high velocity motions in galactic H II regions. Although there is reasonable coverage of the velocity data in many parts of the sky, a consistent theoretical model describing the motions of the gas both in the disc and the halo is yet to emerge. De Boer mentioned in this connection the theoretical work of Shapiro and Field and of Bregman on the Galactic fountain. Very recently, observations by De Boer and Savage of the interstellar lines in the spectrum of Barnard 29 in M13 have suggested that the halo gas does not corotate with the disc as was believed earlier. The data suggest a decrease in the rotational velocity with increasing distance from the plane.

The high velocity motions and complex structure of the Carina region were discussed by Walborn who showed spectacular [S II] interference filter photographs of the region. The data on both the optical and UV interstellar lines of the region indicate high velocities in the range -200 km s^{-1} to $+150$ km s^{-1}. The Carina region is also a source of soft x-rays as observed by the Einstein observatory. According to Walborn, the sources of the kinetic energy in the region are derived from the energetic wind of the Of and Wolf-Rayet stars found in the region. The question as to whether the region contains an unrecognized supernova remnant has not yet been settled.

Ever since the discovery of H_2O maser sources in Orion and W49 more than a decade ago, observations in infrared and millimetre waves have clearly shown the existence of high velocity mass outflows in molecular clouds. More recent indications have come from the data on high rotational lines of CO seen in the submillimetre regions of the spectrum and from quadrupole lines in the vibration-rotation spectrum of H_2. Reviewing the violent activity in dense molecular clounds, Genzel emphasized that the high excitation observed in molecular lines in these regions indicates the presence of hydromagnetic shocks. Further, a bipolar structure of the molecular outflows is seen to be an extremely common occurrence in these clouds as also in compact IR sources, very compact H II regions and in the neighbourhood of T Tauri stars and Herbig-Haro objects. Genzel described in detail the kinematic picture of the Kleinmann-Low region in Orion that has emerged from these observations. It seems unlikely that the outflows are radiatively driven in this region since the momentum in the flow is one to two orders of magnitude higher than the momentum in the radiation field. However, the radiative energy available is more than an order of magnitude higher than the kinetic energy in the outflows and a satisfactory mechanism is yet to be invoked for an efficient conversion of this energy.

The observational status of the soft x-ray background was discussed in the talks by Clark and Kraushaar. Clark reviewed the SAS 3 results and stressed that the observed C-band intensity can be fitted by contributions from two components—a local one from a hot bubble in which we are immersed, and a remote or extended one due to the widely distributed galactic corona. The extended component is absorbed in transmission as is evident from an anticorrelation of the C-band intensity with the column density of the neutral gas. The effective absorption cross-section of the gas is, however, less than the photoelectric absorption, and this indicates a high degree of 'clumping' in the gas. Kraushaar's review included the higher energy M-band data. The existence of emission lines in this band has conclusively proven the thermal nature of the x-rays. Although the C-band and B-band intensities anticorrelate with neutral hydrogen column density, the M-band intensity, according to Kraushaar, does not show such an anticorrelation. Moreover, the origin of the M-band intensity is unknown since it requires substantial amounts of gas at $10^{6.4}$ K rather than at $10^{5.7}$ K as predicted by the McKee-Ostriker theory of a supernova-explosion-dominated ISM. Kraushaar conjectured that a part of the intensity might be extragalactic in origin, whereas the rest could be contributed by local M dwarfs, although a fit to the data would then imply a local density of M dwarfs much higher than the values quoted in stellar surveys.

Cash reviewed the observations of x-ray supershells in the Cygnus, Orion/Eridanus and Carina inner regions. These shells are invariably associated with giant molecular clouds and OB associations with their outer boundaries usually delineated by optical H_α filaments. The absence of these shells in the Gum nebula and Carina outer regions impose stringent requirements on the thermal properties of the x-ray emitting gas. The optical supershells were reviewed by Meaburn who also showed beautiful H_α photographs of regions in the LMC and SMC containing these structures. Meaburn emphasised that these are super-supershells in the sense that their physical dimensions are of the order of a kiloparsec, much larger than the x-ray supershells that Cash described. As a possible mechanism for producing these, Meaburn referred to the theory of stochastic self-propagating star-formation given by Gerola and Seiden. He concluded his review with a brief summary of recent speckle interferometric observations of R136 at the centre of 30 Doradus.

The concluding review of the session was given by Ostriker on the three-phase model of the interstellar medium. He spoke briefly on the original version of the model by McKee and him and described recent improvements of it due to Cowie, McKee and him. He discussed the observational virtues of the model and mentioned in particular its strength in explaining the soft x-ray background, the O VI resonance line and the observed correlation between the radii of supernova remnants and their gas densities. From the theoretical point of view the model is internally consistent and the pressure comes out as a result rather than being assumed *a priori*. However, the model has its problems too and Oxtriker emphasized that the model does not explain the data on neutral hydrogen and disagrees in some of the details with the soft x-ray observations. The cooling shells predicted by the model have so far not been observed either.

(*D. C. V. Mallik*)