REACHING OUT TO THE HEAVENS

By

Dr. Jayant V. Narlikar

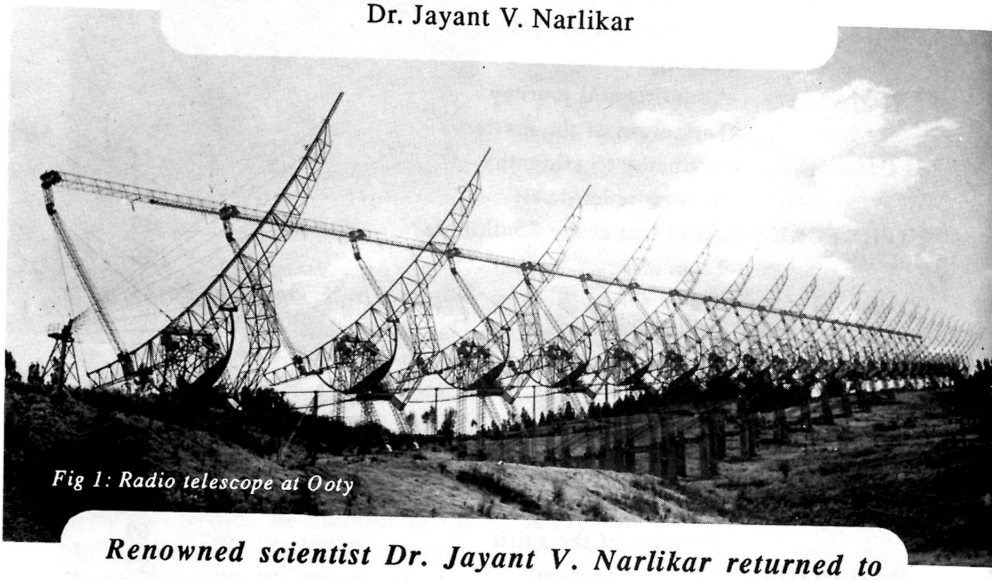

Fig 1: Radio telescope at Ooty

Renowned scientist Dr. Jayant V. Narlikar returned to India after a brilliant 15-year academic and teaching career at Cambridge University. He has now been appointed the first director of the Inter-University Centre for Astronomy and Astrophysics being set up near Pune.

In this article - written exclusively for INDIA DIGEST - Dr. Narlikar discusses the rationale of this unique institution, and its relationship with the giant radio telescope being constructed nearby.

Two major developments on the astronomical front are on their way in India. Both of them will come up on the scenic campus of Poona University, a campus that once formed part of the parks and gardens of the Governor of the Bombay Presidency during the British Raj.

The first of these is the Giant Metre-wave Radio Telescope (GMRT) Centre. The brain-child of Govind Swarup of the Tata Institute of Fundamental Research, Bombay, the GMRT will be the largest metre- wave radio telescope in the world.

What is a radio telescope? In what way is it different from the ordinary telescope that provides a visual view of the cosmos? What is so special about GMRT? Why is it being built in India?

To answer these questions we must go back to the beginning of the era of radio transmission. The radio-set - or wireless receiver of the olden days - brought a new way of communication of information. The messages in a radio transmission are carried by radio waves that travel with the speed of light.

To the physicist, radio waves and light waves are different manifestations of the same phenomenon. The only difference is that radio waves are much longer in length than light waves. For example, when we tune our transistor set to a station on the 25 metre band, the radio waves which bring the programme are some thirty five million times longer than the light waves coming from a red traffic signal.

So, if radio waves can carry man-made signals, can they also not bring in information about cosmic radio sources? Indeed, they can. Just as light from the sun, the stars and the galaxies can tell us about the nature of these cosmic objects, so can radio waves. Karl Jansky in the early thirties, and Grote Reber a decade later, were the pioneers who succeeded in collecting radio waves from remote parts of the universe in their specially designed receivers.

The Giant Metre-Wave Radio Telescope - to be completed by 1994 - will be the largest radio telescope of its kind in the world.

Radio astronomy really took off after the second World War, having gained much from wartime research on radar. Major radio telescopes began to be built. In India, the science of radio astronomy arrived in the sixties, with the construction of the radio telescope at Ooty - a hill station at a height of some 2500 metres in the southern state of Tamil Nadu. (see Fig.1).

Designed and constructed indigenously, this telescope is a gigantic cylinder in the shape of a paraboloid, whose axis is parallel to the earth's axis of rotation. To achieve this configuration, the telescope - more than half a kilometre long - had to be sited on a hill slope in a north-south direction. The advantage of this arrangement is that the telescope cylinder can turn on its axis at an appropriate rate to track a cosmic radio

source as the earth rotates round its axis. (If you wish to view a road-side building from a moving car, you have to turn your neck to compensate for the car's motion.)

The Ooty telescope performed important observations of pulsars, quasars and radio galaxies during the seventies and the early eighties. To Govind Swarup, its creator, the need for an even more ambitious instrument became apparent in the context of the world-wide progress of radio astronomy.

At the same time it was essential to think of a telescope that would be unique, and not a duplication of something already existing in the advanced countries. After considerable brainstorming the idea of GMRT was born.

Radio astronomy can be done at several wavelengths, ranging from a few centimetres to over a few metres. However, the metre-wave band is usually avoided by the industrialized countries, because man-made noise is too loud to make detection of cosmic signals feasible. Thus there exists a gap in our knowledge about the universe at this wave band.

Theoretically too, this band is worth exploring, for the following reason. According to the currently favoured ideas on the origin of the universe, it is believed that the universe came into existence with a big explosion - the 'big bang' - and that it has been expanding ever since. The primeval explosion took place some ten to fifteen billion years ago. However, galaxies like our Milky Way began to be formed about a billion years after that event. Since then the universe has expanded to about five times its size.

It is believed that the galaxies must have been formed from primordial clouds of neutral hydrogen gas. The atoms of neutral hydrogen have a characteristic wavelength of radiation - the well-known 21-cen-

timetre radiation. Even today this radiation is found all over the Milky Way, thus confirming the existence of neutral hydrogen.

However, the primordial 21-cm radiation which was radiated by hydrogen clouds while forming galaxies, would have expanded, along with the universe, to a wavelength five times its original size, that is, to about a metre or so. So just as a radio telescope tuned to receive 21-cm wavelength radiation tells us about the distribution of neutral hydrogen at present, so would a metre-wave telescope tell us about how the hydrogen was distributed in primordial times when galaxies were forming.

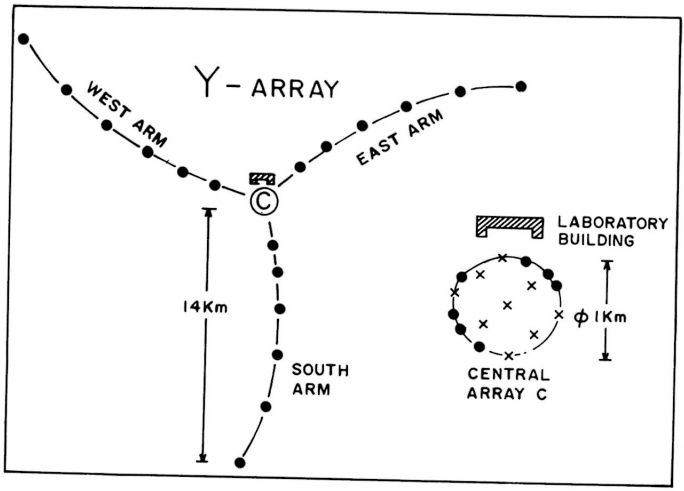

Fig 2 : GMRT array configuration

Thus, the GMRT would be ideally suited to study the important cosmological problem of how and when galaxies were formed. It would in addition, fill the information gap on the radio properties of cosmic sources at the metre wavelength. And, like all other major instruments, it may very well reveal serendipitous facts about the cosmos.

Figures 2 and 3 illustrate the layout and the typical antenna - dish of the GMRT. The layout shows more than thirty such dish type antennas distributed in a con-

figuration containing a central region, and three arms extending out from it in a Y-pattern over several kilometres. Each dish, as shown in Fig. 3 has a diameter of 45 metres.

Evidently one cannot set up such a system in or near a city for lack of space and because of the high level of industrial noise. The GMRT is being sited at Narayangaon, about 90 kilometres from the city of Pune ('Poona' in the British Raj) in a relatively quiet agricultural area. The scientific control of the telescope will be from the GMRT Centre on the campus of Poona University.

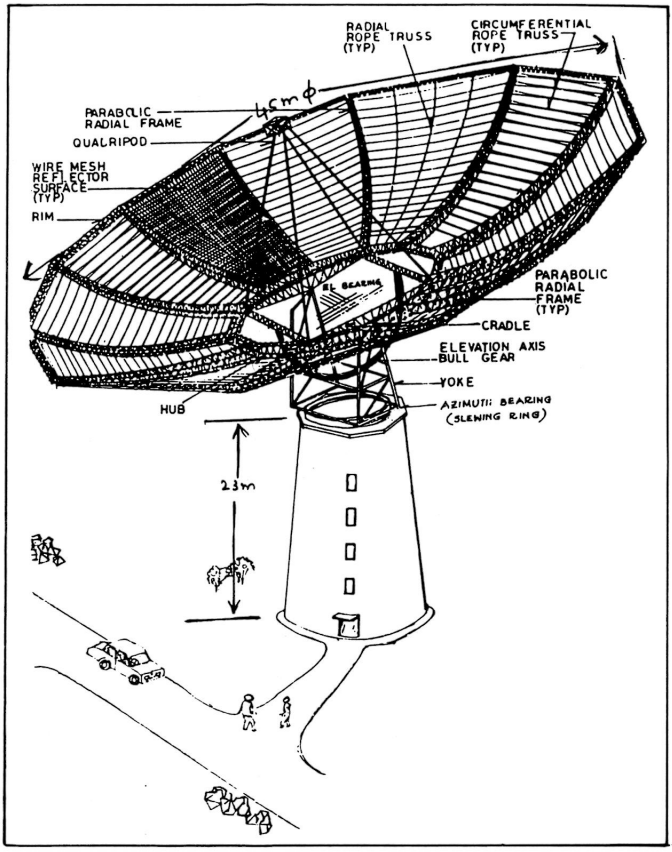

Fig 3 : GMRT antenna dish

The GMRT is slated to be completed in 1992. Although a world class facility like this should, and will, be used by the international community of

astronomers, India would naturally like to provide the largest number of users. Where are these to come from? How can one ensure a significant growth of interest in astronomy and astrophysics in India?

The Centre for Astronomy and Astrophysics will be a centralised facility to be shared by faculties and students of all universities.

The second major project to come on the Poona University Campus has been initiated in response to these questions. The Inter- University Centre for Astronomy and Astrophysics (IUCAA) will be a national coordinating facility to promote the growth of astronomy and astrophysics (A & A) in the university-sector.

The rationale behind IUCAA is as follows. The largest brainpower amongst the younger generation is naturally found in universities. It is amongst the bright young students of today that we may hope to find the astronomers and astrophysicists of tomorrow.

Historically, however, most of the major developments in A & A in India - since the country's independence - have taken place outside the university sector. Apart from the GMRT and Ooty projects, the recently completed Vainu Bappu Telescope (VBT) at Kavalur for optical astronomy, the Millimetre Wave Antenna at Bangalore for microwave astronomy, the infrared telescope on Mount Abu to be completed soon, as well as India's efforts in space astronomy, have all been in specialized institutes that are not easily accessible to the university faculty and students.

So the questions arising about users of GMRT need to be posed in the wider context of these other national facilities also. The answer to them does not lie in creating such facilities in specific universities.

The cost of providing many such facilities to many

universities would be prohibitive. Further, the operation of a facility within the somewhat rigid constitution of a university (say, as a department or as an advanced centre) would pose many problems, and the number of users would be limited.

Logistics therefore require the setting up of a centralized facility to be shared by all university faculties and students interested in A and A. Indeed, in the West, astronomical facilities have already come up on a multi-university, even multinational, basis.

Thus IUCAA will be the universities' field station for A & A. It is the second inter-university centre to be set up by the University Grants Commission (UGC), the first one being in accelerator sciences, on the campus of Jawaharlal Nehru University, New Delhi.

It was Professor Yash Pal, the Chairman of UGC who thought of the idea of setting up IUCAA next to the GMRT Centre in Pune. In this way, he felt, universities will not only benefit from the availability of GMRT, but will actually participate in its construction and usage. It is therefore no accident that IUCAA followed the GMRT Centre on the campus of Poona University.

Astronomy and astrophysics have been identified in India's scientific policy as thrust areas to be given special support by the Government.

IUCAA's role will extend beyond its interaction with the GMRT. In fact, its role is eightfold and may be summarized as follows:

First, IUCAA will have a small core staff carrying on fundamental research in A & A, along with training of post graduate and Ph.D. students. Second, the IUCAA core staff will help nucleate and grow A & A in the university departments, so that eventually many universities will have faculty and stu-

dents working at a reasonably effective level.

Third, IUCAA may help and sponsor the university faculty to prepare guest observer programmes on major national facilities like the VBT, GMRT etc. as well as on international facilities like the Space Telescope. Next, IUCAA will introduce an associateship programme wherein the university faculty can visit IUCAA and use its facilities as associate members. It will also hold refresher courses and advanced level workshops in astronomy and astrophysics.

IUCAA's sixth role will be to create its own laboratory facilities for developing and calibrating astronomical instrumentation and payloads for satellites. Here university departments will be asked to submit specific projects in collaboration with one another, or with the IUCAA core staff. Finally, IUCAA will help popularise science by encouraging amateur astronomy clubs, generating programmes in the media, arranging public lectures etc.

These activities, along with close interaction with the GMRT, determine IUCAA's eightfold way. As I write this article, a beautiful campus, designed by the eminent architect Charles Correa, is being constructed and will be largely complete in 1990.

All these efforts are in conformity with India's scientific policy of giving special support to subjects identified as 'thrust areas' - a list that includes A and A.

While launching IUCAA, Professor Yash Pal expressed a fond hope: "Perhaps we have started on a road which will bring our universities centre-stage... perhaps to a phase when the activities of 'learning', 'finding out' and 'doing' will find their true synergy...perhaps to a culture when the discovery of a single shining jewel anywhere in the country will ensure that pretty soon most of our academics will begin to shine with equal brilliance - and in many more colours." ID