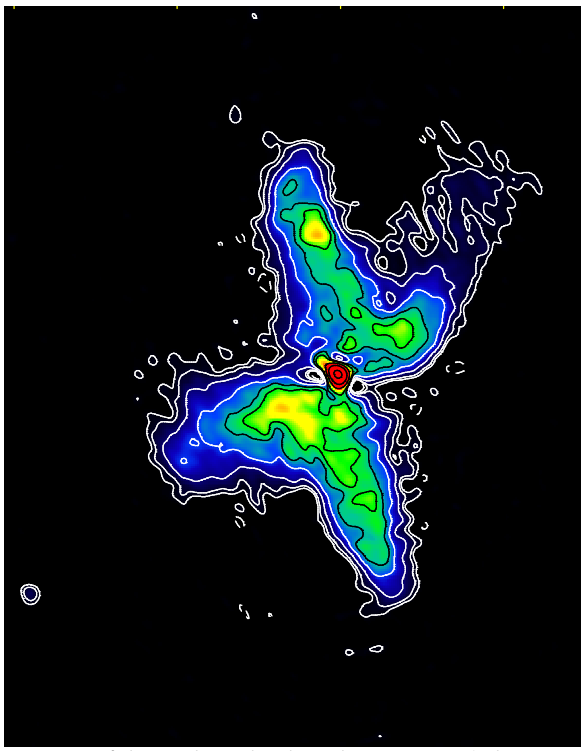
National Centre for Radio Astrophysics

TATA INSTITUTE OF FUNDAMENTAL RESEARCH

Annual Report 2004–05

NCRA–TIFR, PUNE

Annual Report for the year 2004–05



GMRT image of the X-shaped radio galaxy 3C 315. (Dharam Vir Lal)

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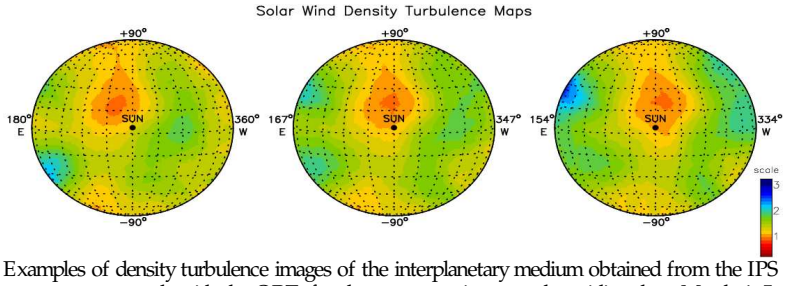
Part 1: Academic Activities

Sun & Solar wind

Large Anisotropy of Solar Wind Density Turbulence: The spectra and images of the solar wind density turbulence obtained from the Ooty IPS measurements in the Sun–Earth distance have been employed to investigate the 2-D structure of density irregularities at a scale size ~200 km. At heliocentric distances R>50 $R_\odot$, the structure of density irregularities of quasi-stationary solar wind was isotropic. However, a remarkable high degree of anisotropy was observed when transients associated with coronal mass ejections (CMEs) intersected the lines of sight to IPS sources. The values of axial ratio ranged between 2 and 5 and the density irregularities were elongated in the direction perpendicular to the radial flow of the ambient solar wind. The above investigation on the structure of density turbulence associated with transients has been extended to Ooty images and spectra of a number of CMEs at different distances from the Sun (i.e., fast and slow CMEs, which also included major geo-effective CMEs). The analysis revealed that the large anisotropy was caused by the interaction of fast CMEs with preceding slow CME(s) and/or solar wind structures. The interaction of the magnetic cloud of the primary CME plays a major role in shaping the density turbulence [P.K. Manoharan].

CME Arrival Prediction: An empirical model to predict the 1-AU arrival time of halo CMEs was made considering the effective acceleration of ~100 CMEs in the Sun–Earth distance. The accuracy of the prediction was improved by considering the distance of acceleration cessation dependent on initial speed of the CME. The model was also examined for each CME's initial speed in space as well as in the projected sky-plane. The results suggested that a correct acceleration profile was crucial for the accurate estimation of 1-AU arrival times of halo CMEs. The study showed average errors of 9 and 11 hours for space and sky-plane initial speeds, respectively [P.K. Manoharan with G. Michalek, N. Gopalswamy and A. Lara]



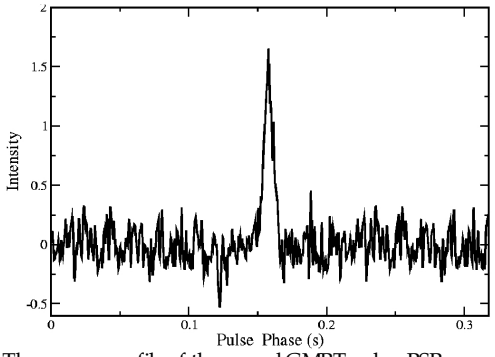
Examples of density turbulence images of the interplanetary medium obtained from the IPS measurements made with the ORT, for three consecutive central meridian days, March 4, 5, and 6, 2005. Such images will be made available at the web site (P.K Manoharan).

Magnetic field Configuration and Properties of CMEs: Solar active regions # 9393 and # 9415 produced a large number of intense flares and associated CMEs which were responsible for a number of severe geomagnetic storms. The characteristics of these mass ejections were studied using data from the Large Angle and Spectrometric Coronagraph on board SOHO and IPS measurements obtained from the ORT. These CMEs showed large variations in size, speed, acceleration, and in the radial dependence. A detail comparison of magnetic field observations of the active regions with the corresponding 'latitude-longitude' maps of the solar wind speed and density fluctuations obtained from Ooty measurements showed that the energy involved in the mass ejection was controlled by the magnetic configuration at and near the mass ejection site [P.K. Manoharan].

Radio Observations of Rapid Acceleration of Filament Eruption: A filament eruption/coronal mass ejection (CME) event associated with a flare of X-ray class M2.8 that occurred on 2001 November 17, was observed by the Nobeyama Radio Heliograph (NoRH) at 17 and 34 GHz. The filament eruption showed a very gradual onset and then a rapid acceleration phase coincident with the launch of a fast halo CME. Soft X-ray and extreme-ultraviolet (EUV) images showed heating in a long loop underneath the filament prior to the flare. When the rapid acceleration occurred in the event, the flare site and the filament were separated by ~ 0.5 $R_\odot$, making it unlikely that a disturbance propagated from one location to the other. Models in which a disruption of the large-scale coronal magnetic field simultaneously permits the acceleration of the filament and the flare energy release seem to be a better explanation for this event [P.K. Manoharan and S. Ananthakrishnan with M.R. Kundu, S.M. White, V.I. Garaimov, P.Subramanian, P. Janardhan].

Pulsars & Compact objects

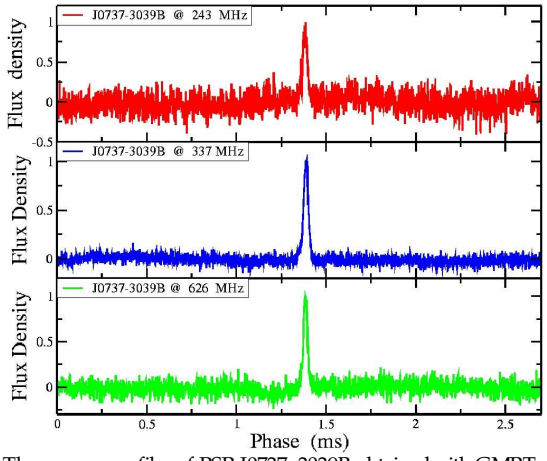
A 610-MHz pilot survey, covering about 40 square degree of sky near the Galactic plane, was carried out using GMRT to discover new long-period pulsars, or pulsars with periods longer than 3 seconds. Finding more of these pulsars is important to provide constraints on the pulsar emission mechanism and to understand the relationship between radio pulsars and high-energy "magnetars". A new pulsar,



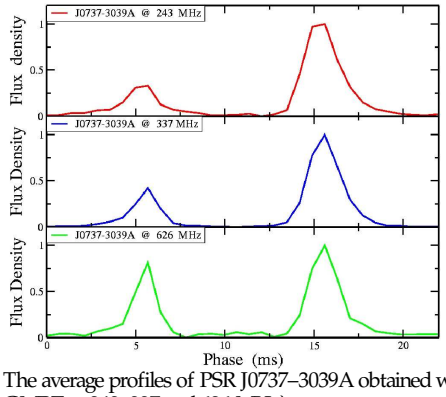
The average profile of the second GMRT pulsar PSR 0026+6320.

PSR J0026+6320, was discovered in this survey and 3 known pulsars were re-detected. Pulsar timing observations, being carried out for PSR J0026+6320 at GMRT and Jodrell Bank observatory, indicate a period 318 ms, a distance of about 8 kpc and a moderate magnetic field. The profile of this pulsar is shown in Figure. This is the second pulsar discovered using GMRT. [B. C. Joshi with A.G. Lyne, O. Hewitt, M. McLaughlin, A. Faulkner, M. Kramer, D. Lorimer]

The follow-up studies of Double pulsar system PSR J0737–3039: In Double Pulsar system, PSR J0737–3039, the line of sight to the millisecond pulsar passes through the magnetosphere of the long period pulsar giving a unique probe of the pulsar magnetosphere. The relatively small separation between the two pulsars, a 17° per year advance in its angle of periastron and a mild eccentricity leads to a varying interaction between the pulsars, observed as a rich phenomenology in their emission. Follow-up studies of this system, since its discovery in 2003, have revealed peculiar modulation of the pulsed emission of the long period pulsar, PSR J0737–3039B (or B) with orbital phase. Observations with Parkes, Green Bank Telescopes and GMRT led to detection of drifting subpulses in one of the two bright phases of this pulsar with a fluctuation frequency of 0.196 cycles per period, indicating a direct influence of J0737–3039A's 44-Hz electromagnetic radiation on PSR B's magnetosphere. Later multi-epoch observations with GMRT at 325 MHz and Parkes Telescope at 1400 MHz indicated a change in the separation and intensities of the two bright phases of B, probably due to geodetic precession of B. Future measurements will provide new tests of relativity as well as constrain theories of pulsar emission. In contrast, the follow up observation with Parkes radio Telescope show no evidence for significant changes in the pulse profile for PSR A, the millisecond pulsar in the system contrary to expectation of large changes due to geodetic precession. These results conclusively rule out a recent geometrical model proposed for the system and imply that the misalignment angle between the rotation axis and the orbit normal is less



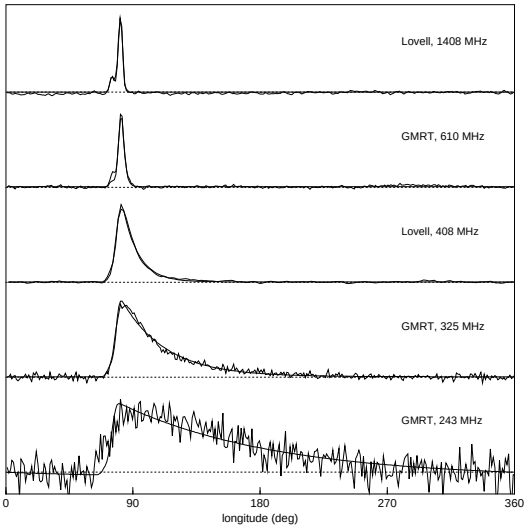
The average profiles of PSR J0737–3039B obtained with GMRT at 243, 337 and 626 MHz}



The average profiles of PSR J0737–3039A obtained with GMRT at 243, 337 and 626 MHz}

than 60°. Due to the edge on orbit of the system, PSR A is eclipsed for about 30 s. Analysis of data from Green Bank Telescope indicated that the pulsed flux density at eclipse is strongly modulated with the periodicity of 2.8 s pulsar and the eclipse is due to synchrotron absorption by the shocked plasma around B. The system was observed at 626, 337 and 243 MHz with GMRT this year to study the multi-frequency behaviour of its low frequency emission. The multi frequency profiles of the two pulsars, obtained in these observations, are shown in Figure and indicate a differential spectral evolution for the two pulsars as well as for the components in their average profiles. [B. C. Joshi with A. G. Lyne, R. N. Manchester, M. McLaughlin, M. Kramer, A. Possenti, M. Buragy, D. Lorimer, F. Camilo, I. H. Stairs, N. D'Amico, P. C. C. Freier, J. Sarkissian].

The frequency evolution of interstellar pulse broadening from radio pulsars: Scattering of pulsed signal from pulsars has been used as excellent probes to study the properties of the electron density fluctuations in the interstellar medium (ISM). The characteristic time scale τ_{sc}, known as the scatter broadening time, scales with frequency and has a spectral index α=4.4 for a pure Kolmogorov spectrum of irregularities in the ISM. Thus it is of interest to find τ_{sc} for pulsars along various lines of sight in the ISM as it throws light on the ISM properties of our Galaxy. In this work we have done multi-frequency measurements of scatter broadening times τ_{sc} for nine medium dispersion measure (DM ≈ 150–400 pc cm^{-3}) pulsars observed over a wide frequency range. The low frequency data at 243, 325 and 610 MHz are new observations done with the Giant Metrewave Radio Telescope (GMRT). The frequency dependence of τ_{sc} for all but one (PSR B1933+16) of our sources is consistent with the Kolmogorov spectrum of electron density fluctuations in a turbulent medium. PSR B1933+16, however, shows a very flat spectrum as previously observed for high DM pulsars. Our observations combined with earlier published results enable us to study for the first time the spectral index of τ_{sc} over the whole observed DM range. While the spectral properties are generally consistent with a Kolmogorov spectrum, pulsars seen along line-of-sights towards the inner Galaxy or complex regions often show deviations from this expected behaviour. Figure shows the variation of the integrated pulse profile of PSR B1831–03 with frequency as an example of the effect of scattering



Integrated pulse profiles and best-fit model profiles for PSR B1831–03 at different frequencies. The profiles at 243, 325 and 610 were observed with the GMRT, whereas the 408 and 1408 MHz profiles were taken from the European Pulsar Network database (Lovell observations). The alignment of the profiles for different frequencies was done with respect to the peak of the main pulse.

over a wide range of radio frequencies. [D. Mitra and Y. Gupta with O. Lohmer, M. Kramer and A.L. Ahuja.]

Sub pulse drifting in wide profile pulsars: Such wide profile pulsars can be interpreted as emission coming from one magnetic pole of a highly aligned pulsar i.e. magnetic axis almost parallel to rotation axis). In such a case, the line of sight is very close to both the rotation and the magnetic axes, and consequently we can sample a large region of the polar cap. Studies of wide profile pulsars can probe detailed distribution of the emission regions in the pulsar magnetosphere. Follow up study of PSR B0826–34: PSR B0826–34, in which emission occurs for nearly 350° of longitude, is a unique pulsar. It exhibits remarkable drifting including simultaneous multiple drift bands and sign reversals of drift rate. Recent study of this pulsar at 325 MHz made with GMRT explained some of these facts. Earlier study of PSR B0826–34 has reported that this pulsar appears to exhibit pulse nulling for 70% of the time. This interesting pulsar has been observed using the GMRT by us at 318 MHz, 610 MHz, 1060 MHz and simultaneously at 303 MHz and 610 MHz in total intensity mode. We have observed this pulsar in polar mode during GTAC cycle 7 at 325 MHz, 610 MHz and 1060 MHz. The total intensity as well as the full polar data were analysed. Reported DM values ranges from 47 pc/cm^3 to 65 pc/cm^3. The simultaneous dual frequency observations done with the GMRT have enabled us to assign a precise DM value equal of 52 $\pm$1.5 pc/cm^3. The study of this pulsar at 325 MHz, 610 MHz and 1060 MHz has given more details of the outstanding pattern of drifting. The drift rate shows wide variation including sign reversal. We see 6–7 drift band in the main pulse region and 2–3 drift bands in the interpulse region. Our analysis shows first clear variation of P2 of the drift bands as a function of observing frequency (at 325 MHz P2 = 25.5 deg, 610 MHz P2 = 26.9 deg, 1060 MHz P2 = 27.3 deg). Sub pulse separation is observed to be dependent on pulse phase as well and we are investigating this in details. Esamdin et al., 2004, have observed some weak emission properties while the pulsar was in so called null state. Results obtained from preliminary analysis do not show any evidence for emission in null state. The polarization data quality of our observation is significantly better than earlier results (Biggs et al., 1985). We see significant linear polarisation (20–50%) in the main pulse region and linear polarization drops abruptly near the edges of the main pulse. Also two orthogonal mode jumps and depolarization of linear polarization occur close to the edges of the main pulse. We have seen significant circular polarisation in the main pulse region, along with sign reversal near the centre. By studying the behaviour of the polarization angle we expect to develop a view towards the non dipolar field structure and also towards the emission geometry. [Bhaswati Bhattacharya, Y. Gupta with J. Gil]

Wide Profile Pulsars: GMRT observations of a set of 11 selected wide profile pulsars were carried out at 325 MHz and 610 MHz in total intensity mode. Detailed analysis of the data has been done and some new interesting results have emerged. It has been detected for the first time, very interesting drift behaviour for one of these wide profile pulsars. It appears that there are two distinct drift regions in the pulse window of this profile: an inner region with steeper apparent drift rate, flanked on each side by a region of slower drift. Multiple drift bands (typically 3 to 4) can be seen in the inner region of any single pulse, whereas the outer regions show only a single drift band spanning the pulse window there. We have detected drifting subpulses for 4 other pulsars in the set. [Bhaswati Bhattacharya, Y.Gupta with J. Gil].

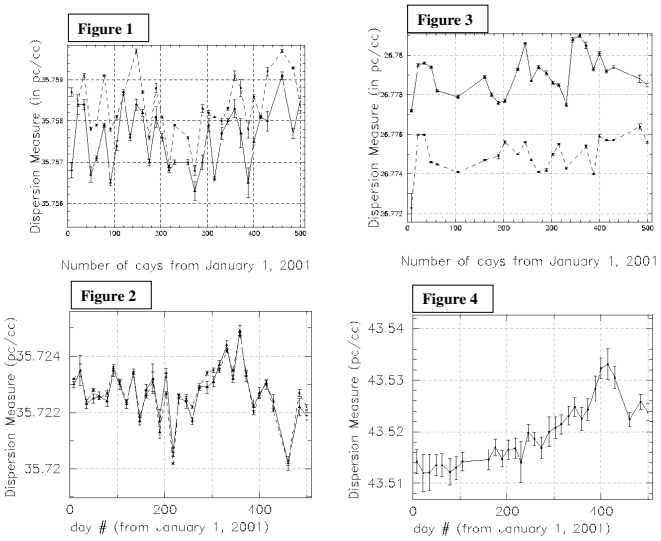
Long term monitoring of Gamma Ray Bursts: The Gamma Ray Burst (GRB) of March 29, 2003 was the second brightest GRB known so far. This GRB has been monitored with GMRT for the last two years, starting from second day after the burst. Along with simultaneous observations at higher frequencies using several telescopes across the world, the GMRT data provided important constraints on the self-absorption frequency of the emission region and the epoch of non-relativistic transition of the fireball. [C.H. Ishwara-Chandra with L. Resmi, A.J. Castro-Tirado, et. al].

Timing Properties of Cygnus X-3: The binary corrected X-ray light curve of Cygnus X-3 using the RXTE-ASM (All Sky Monitor) data and RXTE-PCA data were studied and found that the X-ray template derived from the EXOSAT observations adequately explains the binary variations. Using the recently determined quadratic binary ephemeris we corrected the RXTE-PCA light-curve and obtained the power spectrum which shows distinct features of shifting towards the low frequency regime vis-à-vis the Galactic X-ray binaries. The power spectrum doesn't vary from the hard to the soft state. We also obtained the binary corrected RXTE-ASM monitoring light-curve and examined the previously obtained correlation between soft X-ray (2 – 12 keV from RXTE ASM), hard X-ray (20 – 100 keV from CGRO – BATSE) and radio (2.2 GHz from GBI) after the binary correction and found that the correlation time scale is less than a day. [M. Choudhury, A.R. Rao with A.K. Jain, N.S. Singh]

The lagged anti-correlation of hard X-rays: Continuing the study if the anti-correlation of the hard X-ray vis-à-vis the soft X-rays, we used the binary corrected light-curve in the two bands to obtain the time scale of the anti-correlation to be of the order of few hundred to thousand seconds. This lagged anti-correlation of the hard X-rays gives rise to the pivoting feature in the spectral evolution of the source. The lag time scale may be attributed to the viscous time scale of flow of matter in the accretion

disk. This suggests the geometrical picture of a truncated accretion disc with a Compton cloud inside the disc, the relative sizes of which determine the spectral shape. Any change in the disc structure will take place in a viscous time scale, with corresponding anti-correlated change in the Compton cloud. [M. Choudhury, A.R. Rao].

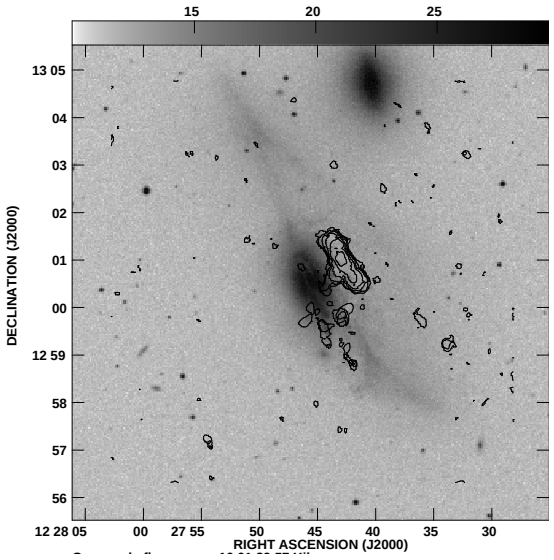
A novel experiment for the estimation of pulsar dispersion measure (DM) along the line of sight to a sample pulsar has been carried out using the Giant Meter-wave Radio Telescope (GMRT). This involved simultaneous dual frequency pulsar observations of a sample of twelve pulsars using the GMRT over a period of more than one year. GMRT is an ideal instrument for such an experiment. This is the first time that pulsar DMs have been measured from dual frequency, single epoch, by using the cross-spectrum signal processing technique. This way we have managed to calculate DM to accuracies of 1 part in 10^4 and better. In Figure we show the measured DM's for 4 pulsars and its temporal variation. See figure caption for more details. [Y. Gupta, D. Mitra with A.L. Ahuja and A. Kembhavi]



Variation of DM (3s error bars) with time for pulsars B1642-03 (observed at 325+610 MHz) (Firure 1), B1642-03 (Observed at 243+325 MHz) (Figure 2), B0329+54 (Figure 3), and B2217+47 (Figure 4) over the interval 08 January 2001 to 14 May 2002, as a function of day number. The continuous lines show the results from average profile and the dashed one from the single pulse method.

Galactic Astronomy

Multifrequency study of the nova remnant GK Persei: Multifrequency radio continuum observations using GMRT, optical observations using the HCT and archival VLA data at higher radio frequencies have shown interesting results. We find that the radio continuum spectrum at frequencies lower than about 1 GHz is steeper with an index –0.85 whereas the higher frequencies the spectral index is –0.7. Moreover we find, for the first time in this nova remnant, that the spectrum above about 1 GHz shows a annual secular decrease of 2.1% in the flux density, which can be explained by adiabatic expansion of the remnant, and which is absent at the lower frequencies. We argue that there are at least two electron populations which give rise



The GMRT total-intensity HI contour-map of NGC4438 superimposed on the DSS blue-band image

to the observed radio emission and which peaks at different frequencies. We conclude that the remnant of GK Per is similar to supernova remnants, in particular Cas A. [N.G. Kantharia with G.C. Anupama]

Detecting the largest bound atom in space: Using the UTR-2 radio telescope in Ukraine, we have made deep carbon radio recombination line observations near 26 MHz of the gas in front of the strong supernova remnant, Cas A. This has resulted in a high signal-to-noise spectrum in which we detect α near $n=635$, β near $n=800$, γ near $n=915$ and δ near $n=1010$ transitions. This is the first time that radiation from a bound atom has been detected in such an excited state i.e. $n=1010$. Collisional broadening has clearly affected the δ line and the large Lorentzian wings of adjacent transition overlap. Detection of the δ line implies that the size of the radiating atom is of the order of 100μ! [N.G. Kantharia with Sergiy Stepkin and A. A. Konovalenko and N. Udayashankar]

Extragalactic Astronomy

Nearby Galaxies: The Virgo cluster galaxy NGC4438, which has a Seyfert nucleus, has been observed with with the GMRT at 325 and 610 MHz, and in H I, and also with the VLA A-array at 8 GHz. The galaxy exhibits collimated emission towards the east and diffuse radio emission on the western side, extending up to ~10 kpc. Extended Hα, soft X-rays, CO and H I emission are all seen to the west of the main stellar disk. A massive (2×10^8 $M_\odot$) linear H I-emission structure ~5 kpc away and roughly parallel to the galaxy disk has been detected on the western side in the GMRT observations. The linear structure has a velocity gradient of ~100 km s^{-1} in the same direction as that of the rotation of the galaxy determined from CO images. There is also diffuse H I emission on the southern side of the galaxy, which have features which are blue-shifted by up to ~100 km s^{-1} relative to the linear structure. A central outflow driven by the AGN, ram pressure stripping, while the galaxy moves in the dense Virgo cluster medium, as well as tidal interactions with the northern companion all help shape the complex structures which are observed [Ananda Hota and D.J. Saikia with Judith A. Irwin].

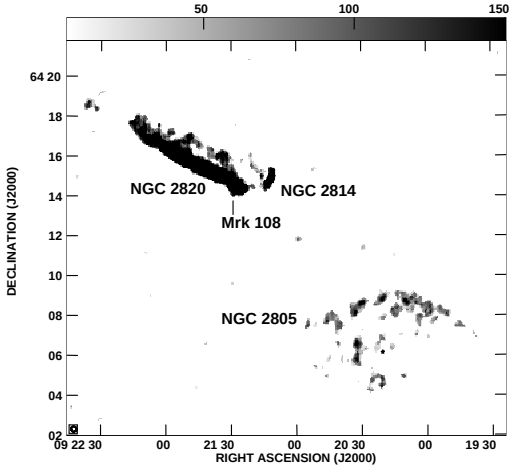
Compact steep spectrum sources: Compact Steep-spectrum Sources (CSSs), defined to be less than about 20 kpc in size and having a steep high-frequency radio spectrum, have received a great deal of attention in recent years. The general consensus is that these are largely young sources seen at an early stage of their evolution. As CSSs have been shown to be more asymmetrical than larger sources of similar powers, there is a high probability that they interact with an asymmetric medium in the central regions of the host elliptical galaxy. A simple analytical model of the propagation of radio jets through a reasonable asymmetric environment has been considered and shown that they can yield the range of arm-length and luminosity asymmetries that have been observed. This has been generalized to allow for the effects of orientation, and quantify the substantial enhancements of the asymmetries that can be produced in this fashion. Two-dimensional and three-dimensional simulations of jets propagating through multi-phase media have been presented and shown that the results from the simulations are also broadly consistent with the observations. [D.J. Saikia with S. Jeyakumar, Paul Wiita and Jagbir S. Hooda].

Outflowing material in the CSS quasar 3C48: The detection of a z_{abs}=0.3654 associated, absorption-line system in the ultraviolet spectrum of the CSS quasar 3C48 has been reported. The absorbing material is blueshifted with respect to the quasar emission-line redshift, z_{em}=0.370, suggesting an outflow velocity of ~1000 km s^{-1}. Absorption lines have been detected over a range of ionization states from Lyβ, Lyγ, C IV, N IV, S VI to O VI and possibly Ne VIII. The kinematical properties of the absorption-line system are similar to the blue-shifted emission line gas seen in [OIII]λ5007, which is believed to have interacted with the radio jet. The properties of the absorbing material have been studied using CLOUDY and it has been found that photoionization models with the Solar abundance ratios (with overall metallicity in the range $0.1 \leq Z / Z_{\odot} \leq 1.3$) are enough to explain the observed column densities of all the species except Ne VIII, detection of which requires confirmation. Because the cooling and recombination time for the gas is ~10^5 yr, the consistency with the photoionization models suggests that the jet-cloud interaction with the absorbing material must have taken place before ~10^5 yr. The abundance ratio of nitrogen to carbon is close to Solar values, unlike in the case of most quasars, especially at high redshifts, which have super-Solar values. 3C48 has been observed several times with the GMRT to search for redshifted 21cm H I absorption. However, no significant feature has been detected; the 3σ upper limit to the optical depth has been estimated to be 0.001–0.003. However, due to the diffuse nature of the radio source optical depths

as high as 0.1 towards individual knots or compact components cannot be ruled out. [Neeraj Gupta and D.J. Saikia with R. Sriamand].

Giant radio sources: A detailed spectral ageing analysis for the giant radio sources, J0912+3510, has been done using observations at 330 and 600 MHz with the GMRT and at 4860 MHz using the VLA. Using the SYNAGE software developed by M. Murgia, the injection spectra have been estimated to be 0.56 and 0.63 for the northern and southern lobes respectively. There appears to be some evidence of a decrease in the spectral age with increasing separation from the hotspots before appearing to increase as it approaches closer to the core. This decrease is possibly due to in situ acceleration near the hotspot regions. The maximum age detected is about 30 Myr and the mean velocity is estimated to be ~0.1c. [C. Konar and D.J. Saikia with J. Machalski and M. Jamrozy from Jagiellonian University Astronomical Observatory, Poland].

High-resolution observations made with the GMRT of associated HI from the radio galaxy 3C268.3 located at redshift of 0.37 show absorption of about 1% (51 mJy), with peak of the absorption line located close to the north-west lobe of the double source with a separation of 2 arcsec between the two lobes, close to the diffuse optical emission region detected near the NW lobe from HST observations by de Vrois, indicating perhaps absorption by the HI gas of the merging optical galaxy [G. Swarup and S.K. Sirothia; in preparation].

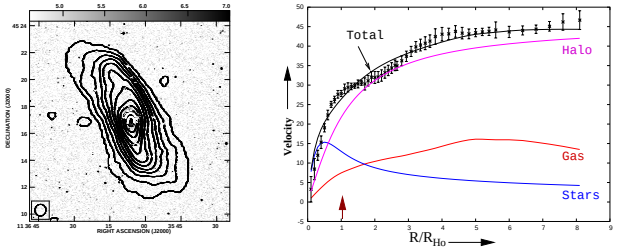


HI emission from the poor group Holmberg 124. Note the smooth boundary to the south of NGC 2820 and the large HI loop to its north. Also note the sharp cutoff to the north of NGC 2814.

Tidal interaction or Ram pressure in Ho 124: Analysis of multi-frequency GMRT radio and HI 21 cm observations of the poor group of four galaxies called Holmberg 124 have yielded interesting results. Various tidal features like a steep spectrum radio continuum bridge, a streamer, a tail were detected in the four members of the group. Moreover, we detect several features like a large HI loop to the north of NGC 2820 (see Figure) with no ionized counterpart, a smooth boundary to HI distribution in NGC 2820 and NGC 2814 and enhanced star formation in NGC 2805 which we propose are likely due to the effect of ram pressure of the intra-group medium on the interstellar medium of the galaxies. We thus suggest that this group of late type galaxies has been subjected to both tidal interaction and ram

pressure due to the motion of the member galaxies in an intra-group medium. [N.G. Kantharia, S. Ananthakrishnan, R. Nityananda, Ananda Hota]

GMRT HI 21cm images of a nearby dwarf irregular galaxy NGC 3741 (M_B ~ –13.13), which show it to have a gas disk that extends to ~8.3 times its Holmberg radius, were presented. This makes it probably the most extended gas disk known. Our observations allow us to derive the rotation curve (which is flat in the outer regions) out to ~38 optical scale lengths. NGC 3741 has a dynamical mass to light ratio of ~107 and is one of the "darkest" irregular galaxies known. However, the bulk of the baryonic mass in NGC 3741 is in the form of gas and the ratio of the dynamic mass to the baryonic mass (~8), falls within the range that is typical for galaxies. Thus the dark matter halo of NGC 3741 has acquired its fair share of baryons, but for some reason, these baryons have been unable to collapse to form stars. [Ayesha Begum & J.N. Chengalur].

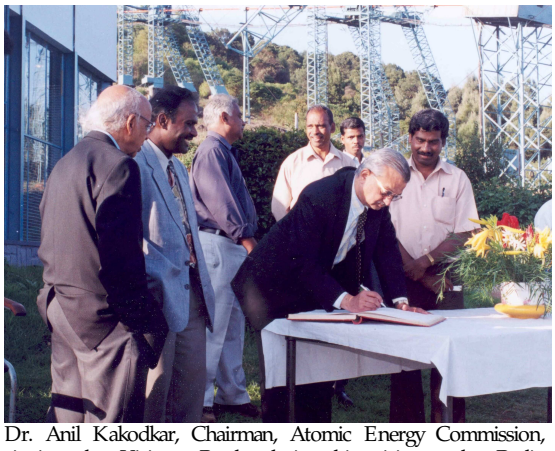


Left: HI column density distribution of the galaxy NGC 3741 as observed with the GMRT. Right: Mass model for NGC 3741 using the derived rotation curve (shown as points).

Part 2: Instrumentation & Facilities

Ooty Radio Telescope

On Muthorai Cylinder various types of dipole feeds have been tested and multi-frequency spectra of solar bursts have been recorded [D. Nandagopal and A.J. Selvanayagam].



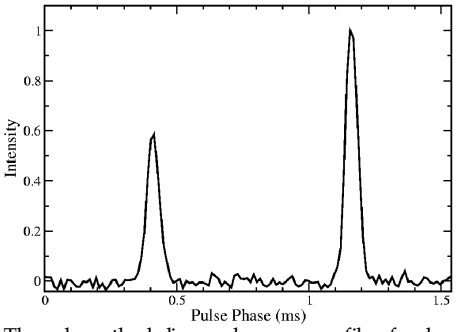
Dr. Anil Kakodkar, Chairman, Atomic Energy Commission, signing the Visitors Book, during his visit to the Radio Astronomy Centre, Ooty. Prof. Govind Swarup and Dr. P.K. Manoharan, Head RAC Ooty are also seen.

A PC based remote display system has been designed and installed on the control panel of the ORT. This system can read time information from an ACCORD GPS or from a clock interface. Along with this system, the EPLD based encoder interface has also been integrated. It displays, IST, LST, Julian Day, and HA for any given RA on the monitor of the computer. This system works on Linux operating system [K. Kalyanasundaram and group].

Giant Metrewave Radio Telescope

Location of Radio Frequency Interference using the GMRT Array: Computer simulations were made to investigate the possibility of detecting sources of radio frequency interference using the central array of the GMRT, without ambiguity due to the expected side-lobes of the array towards horizon for short observations; the feasibility of locating RFI sources was established. Consequently test observations were made in March 2004 by transmitting a signal at a known location located 7 km away from the central array of GMRT, whose position was measured using GPS and another transmitter at an 'unknown' position. A calibration, data processing and search procedure has been developed. It was shown that the position of the 'unknown' transmitter located about 5 km away from the Central array of the GMRT could be measured. Technical Reports have been prepared and are being released to the NCRA library shortly. [Anirban Chatterjee, G. Swarup, Sachin Pathak, Vishal Kale].

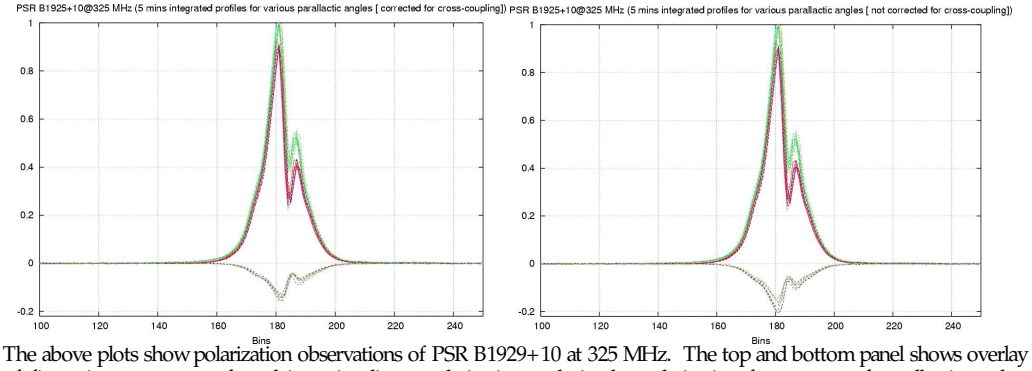
Development of a new software pulsar receiver for GMRT: A new software based pulsar receiver using a cluster of 4 Pentium personal computers is being developed at GMRT. The receiver is based on a high speed data acquisition card, which is capable of acquiring 16 MHz two polarization data available at GMRT array combiner at a rate of 64 Mbytes per second. The receiver can be configured to record the baseband data upto a maximum bandwidth of 4 MHz to disk with a sampling time of 250 ns for offline coherent dedispersion. The receiver was tested with high time resolution observations of several pulsars. Figure 3 shows a high time resolution coherently dedispersed profile of PSR B1937+21, which is a 1.5 ms pulsar. The receiver will be useful for high precision timing studies of pulsars. In a second mode, the receiver can be configured to obtain 4 stokes pulsar data for full 16 MHz bandwidth with a sampling time of 256 μs. There is a facility for online display of pulsar data. Currently, the receiver is being tested for stability and a user friendly interface is being developed. It will be available for routine observations in the near future. [B C Joshi with Sunil Ramkrishna, A. B. Adoni, M. Umbarje]



The coherently dedispersed average profile of pulsar PSR B1937+21 obtained with the new software pulsar receiver.

Streamlining Pulsar data format: In GMRT there has been a need for having a standard pulsar header while doing pulsar observations and convert the data into a standard format. We have now worked towards getting these issues streamlined and have produced the GMRT pulsar header. Further we have also set up the required data processing pipelines and convert the observatory recorded data format into the currently internationally used European Pulsar Network (EPN) data format. This fascility will help any user to obtain GMRT pulsar data in the EPN format and can be analyzed and used readily. In the long run the EPN formatted data can be archeived for interested scientists to use them as per the institute's policy. [D. Mitra, Y. Gupta, S. Kudale, Gupta with R. Smits.]

Pulsar Polarization Calibration: Currently in GMRT the backends for doing pulsar observations in the phased array (PA) mode can be used to do polarization observations. This fact has already been demonstrated by earlier polarization work done in GMRT. However, without appropriate polarization calibration (which has not yet been attempted in GMRT), usage of the polarization mode for scientific purpose is



The above plots show polarization observations of PSR B1929+10 at 325 MHz. The top and bottom panel shows overlay of five minutes average of total intensity, linear polarization and circular polarization for a range of parallactic angles. Left panel: Note that the circular polarization shows a spread of about 10% which is due to the effect of cross coupling. Right Panel: Here the cross couplings corrections are done to the profiles and hence note that the spread in the circular polarization has reduced to about 2%.

not possible. Thus we have taken up the task of polarization calibration with the telescope operating in the PA mode and using pulsars as calibrators. Our goal is to firstly characterize the polarization cross coupling characteristics at several wavebands and eventually find a suitable scheme to do the calibration. We have mostly used the system test time available for this purpose. As a first step we have acquired data at 325 MHz and have been able to conduct a suitable experiment and find the cross coupling parameters. Figure shows that the circular polarization is affected due to the cross coupling by about 10%. By correcting for the cross coupling we can reduce the effect to less than 2%. We are currently in the process of standardizing the calibration scheme and extending the scheme to other radio bands. [D. Mitra, Y. Gupta and S. Kudale]

GTAC Activities

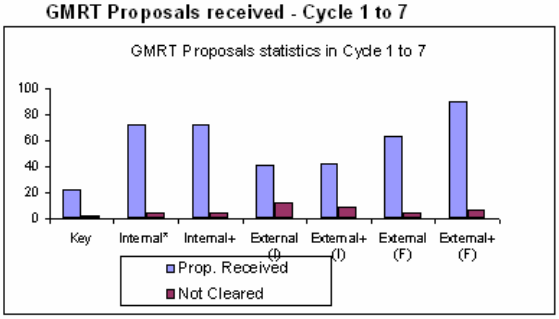
From the beginning of 2002, the GMRT has run as a full fledged international observational facility for radio astronomy below 1.4 GHz and completed 7 observation cycles, approximately 6 months each. GMRT Control Centre (GCC) makes sure that at least 27 antennas are available for observations. Weekly maintenance downtime is approximately 1.5 days per week and 2 months between 2 cycles. Cycle 6 ran from June 2004 to October 2004 and Cycle 7 ran from November 2004 to April 2005. On the average, each cycle has been getting 50-55 proposals which are screened by GMRT Time Allocation Committee (GTAC) and scheduled based on their recommendations.

Several Target of Opportunity (ToO) proposals sent to Centre Director are approved and scheduled and interesting results have been emerging. Observing in the 150 MHz band has been started by experienced users and GTAC is receiving proposals for this band. RFI continues to be a problem but in spite of it, results are emerging. 6 NCRA research students are using GMRT data for their thesis work.

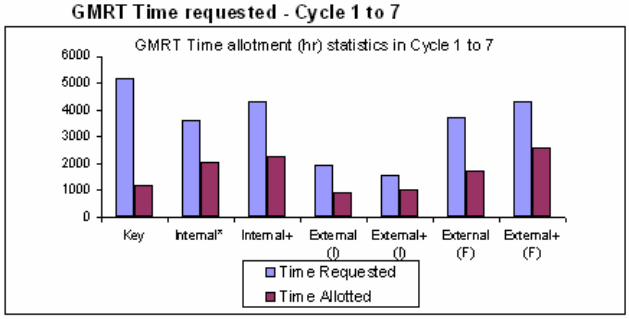
Streamlining and automating various procedures is under way. The statistics for the seven cycles are given below:

Categories	Prop. Received **(Nos)**	Time Requested **(Hours)**	Time Allotted **(Hours)**	Not Cleared **(Nos)**
Key	22	5163	1193	3
Internal	73	3591	2067	5
Internal+	73	4287.5	2240	5
External (I)	41	1968	908	12
External+ (I)	43	1562	1001	9
External (F)	64	3693	1715	5
External+ (F)	90	4305	2563	7
Total	**406**	**24569.5**	**11687**	**46**

GMRT Proposals received - Cycle 1 to 7



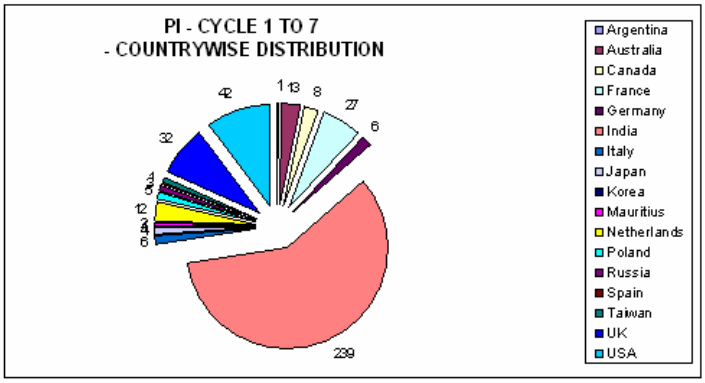
GMRT Time requested - Cycle 1 to 7



Categories

Key:	Key proposals
Internal:	PI and Co-Is from TIFR
Internal+:	PI from TIFR, Co-I non-TIFR
External (I):	PI & Co-Is not from TIFR, but from other Indian Institutions
External+ (I):	PI non-TIFR, with atleast one Co-I from TIFR
External (F):	PI & Co-Is from abroad.
External+ (F)	PI from abroad, with atleast one Co-I from India

COUNTRY	No. of proposals
Argentina	1
Australia	13
Canada	8
France	27
Germany	6
India	239
Italy	6
Japan	4
Korea	1
Mauritius	2
Netherlands	12
Poland	5
Russia	3
Spain	1
Taiwan	4
UK	32
USA	42
Total	**406**



Library

Around 200 books were added both at NCRA/GMRT libraries during the financial year. The library subscribed to around 110 journals for NCRA, GMRT and RAC library. During 2004-05 250 bound volumes were added in the library. Around 40 articles were provided on ILL to other libraries. About, 35,000 pages of photocopies were supplied to library users.

Library users are able to access the following electronic journals/databases:

- Annual Review of Astronomy & Astrophysics
- IEEE Electronic Library
- Nature
- Science
- Science Direct
- Springer Link Services

Several duplicate issues of journals were available at NCRA library. A large collection from this was donated to M. P. Birla Institute of Fundamental Research, Bangalore on exchange basis during March 2005. During the period, library took initiative in providing new web based services for the members at NCRA and GMRT.

For creating web based services, an in-house system was developed using open source software such as MySQL a relational database system and PHP scripting language. The following are the new such initiatives:

Papers published using GMRT: A fully searchable database of papers published using GMRT was created using MySQL. This database currently holds 89 papers which are published using GMRT. Database can be searched by Title, Authors, Affiliation, Source, Keywords etc. Full text link of each paper is also provided for accessing full texts. For more details visit:

http://lib-pc.ncra.tifr.res.in/database/gmrtpubl/advancepubsearch.php

NCRA Technical Reports: A database of all technical reports available at NCRA library is created and full text of all these reports are linked through intranet services.

This database is available as a searchable database. One can search records by word, Author, Title, Date of Publication. For more details follow link

http://lib-pc.ncra.tifr.res.in/database/technical/techsearchform.php

Union catalogue of journals subscribed in all astronomy libraries from India. (FORSA journal holdings catalogue): NCRA library developed a database of journal holdings of all journals subscribed at the astronomy libraries from India. The following are the participating libraries:

Indian Institute of Astrophysics (IIA), Bangalore, Inter University Centre for Astronomy and Astrophysics (IUCAA), Pune, National Centre for Radio Astrophysics (NCRA), Pune, Physical Research Laboratory (PRL), Ahmedabad, Raman Research Institute (RRI), Bangalore, Saha Institute of Nuclear Physics (SINP), Kolkata, S N Bose National Centre for Basic Sciences, Kolkata and the Tata Institute of Fundamental Research, Mumbai.

This database is a valuable resource for locating any journal available in the above libraries through internet. This database holds around 3000 records.

Computing Facilities

We have recently installed 3 HP Proliant servers for acquiring and analysing data at GMRT. This has provided enough redundancy in the system and ensures smooth operation of data acquisition pipe line even if some sub systems in the pipeline fail. We have upgraded all the computers that were being used for GMRT data analysis and installed latest versions of AIPS and GMRT offline analysis package. In addition to the 64kbps link to TIFR Mumbai we have a 1024kbps link from NCRA Pune to VSNL Pune and one 64kbps link from NCRA Khodad to VSNL Arvi. Our Pune campus and Khodad campus are connected by optical fibre link with a bandwidth of 100Mbps. This provides fast connection to the external world to access articles from journals and data from other observatories. Moreover it gives some protection against failure of one link.

Part 3: Other activities

National and International Involvement

S. Ananthakrishnan

Member, Engineering Working Group and the Site Evaluation Working Group, Square Kilometer Array.

Gopal Krishna

Coordinator, GMRT Time Allocation Committee (GTAC)

Member, Subject Board for Physics (TIFR)

Member, Standing Review Committee TAUVEX Payload (ISAC, Bangalore)

Adjunct Professor, ARIES (Nainital)

C.H. Ishwara Chandra

Member, Local Organising Committee, SKA 2005, NCRA-TIFR, Pune.

B.C. Joshi

Member, Parkes Multibeam pulsar survey team

P.K. Manoharan

Chief convenor, Solar Terrestrial Session # 1, Asia Oceania Geosciences Society (AOGS) Conference, Singapore.

Co-investigator, RT-2 Experiment onboard Corona-Photon Satellite, TIFR-ISRO Project.

Member, science panel of Space-Weather Science and Application, ADCOS.

R. Nityananda

Editor, Journal of Astrophysics and Astronomy, Indian Academy of Sciences.

A. Pramesh Rao

Chairman, Local Organising Committee, SKA 2005 Meeting, NCRA–TIFR, Pune.

Member, Scientific Organising Committee, SKA 2005 Meeting, NCRA–TIFR, Pune.

D.J. Saikia

Associate Editor, Bulletin of the Astronomical Society of India.

Member, advisory committee for the Space Physics Centre, Kolkata.

Visits

S. Ananthakrishnan

Square Kilometer Array (SKA) Conference
Penticton, Canada
July 12–23, 2004.

University of California, Davis
July–August, 2004.

SKA meeting,
Guyang, China
March 12–17, 2005

Gopal Krishna

Third Korean Astrophysics Workshop
Pusan National University, Korea
August 2004

ARIES, Nainital
October 2004

Institute d'Astrophysique de Paris
December 2004

Osmania University, Hyderabad
February 2005

C.H. Ishwara Chandra

Fifth microquasar workshop: Microquasars and related astrophysics
Tsinghua University, Beijing, China
June 7 - 13, 2004.

Search for radio emissions from extra-solar planets
International Space Science Institute, Bern, Switzerland
November 1 - 5, 2004.

B.C. Joshi

23rd Conference of Indian Association for General Relativity and Gravitation (IAGRG),
University of Jaipur, Jaipur, India,
December 7 – 10, 2004.

COSPAR Colloquium: Spectra and Timing of Compact X-ray Binaries,
TIFR, Mumbai, India,
January 17 – 21, 2005

23rd Meeting of Astronomical Society of India,
Aryabhatta Research Institute for Observational Sciences (ARIES), Nainital, India,
February 21 – 24, 2005

N.G. Kantharia

Raman Research Institute, Bangalore
October 2 to October 8, 2004

A. Pramesh Rao

SKA Conference and ISSC Meeting,
Penticton, Canada,
July 2004

CEA,
Saclay, France,
July 2004

ARIES,
Nainital,
September, 2004

SKA Meeting and ISSC Meeting,
Guiyang, China,
March 2005

D.J. Saikia

(i) Jodrell Bank Observatory, (ii) University of Manchester, (iii) Department of Physics and Astronomy, Oxford University and the (iv) Mullard Radio Astronomy Observatory, Cambridge
June–July 2004.

Awards & Distinctions

S. Ananthakrishnan

President, Indian URSI 2003–2006

Y. Gupta and D. Mitra

1st prize for the poster presentation at the 23rd meeting of the Astronomical Society of India, ARIES Nainital
February 21–24, 2005.

Invited Talks

S. Ananthakrishnan

Square Kilometer Array, Academy-Industry Interaction Meeting,
GMRT Observatory, Khodad
June 19, 2004

Summary on GMRT,
US-India Meeting on Space Technology and Commerce, Bangalore
June 22, 2004

Giant Metrewave Radio Telescope instrumentation,
Medicina, Italy
July 2, 2004

Science from GMRT,
Bologna, Italy
July 2, 2004

Observations of the Sun,
Theoretical Plasma Physics workshop, ICTP, Trieste, Italy,
July 6, 2004

Science with the Giant Metrewave Radio Telescope,
Cosmolgy Seminar, University of California, Davis, USA,
July 30, 2004

Giant Metrewave Radio Telescope and Observations of the Sun,
Colloquim, Naval Research Lab., Washington DC,
August 27, 2004

Introduction to Astronomy,
C.T.Bora College, Shirur,
February 7, 2005

Ayesha Begum

Dark matter in dwarf galaxies
IAGRG meeting, Jaipur, India,
December 8, 2004.

Dwarf galaxies
23rd ASI meeting, ARIES Nanital, India,
February 21, 2005.

M. Choudhury

Cygnus X-3: A Phenomenological Perspective
23rd ASI Meeting, Nainital,
February 17–21, 2005.

Gopal Krishna

Low-level Radio Emission from Radio Galaxies and Implications for the Large-scale Structure
International Conference on Cosmic-rays and Magnetic Fields in the Large Scale Structure, Busan,
August, 2004

B.C. Joshi

Giant Meterwave Radio Telescope,
23rd Conference of Indian Association for General Relativity and Gravitation (IAGRG), University of Jaipur, Jaipur, India,
December 8, 2005

Constraints on GR from pulsar observations,
23rd Conference of Indian Association for General Relativity and Gravitation (IAGRG), University of Jaipur, Jaipur, India,
December 8, 2005

Changes in radio emission from PSR J0737–3039B, Spectra and Timing of Compact X-ray Binaries — COSPAR Colloquium,
TIFR, Mumbai, India,
January 18, 2005

GMRT Observations of Double Pulsar PSRs J0737-3039
23rd Meeting of Astronomical Society of India, ARIES, Nainital, India, February 23, 2005

P.K. Manoharan

Imaging solar coronal mass ejections from Sun to 1 AU: Predicting their arrivals at earth,
23rd ASI Meeting, ARIES, Nainital,
February 21 - 25, 2005.

Study of CMEs from Sun to near-Earth Environment,
School of Physics, Madurai Kamaraj University, for the UGC-DRS seminar series,
March 11, 2005.

Large anisotropy of solar wind density turbulence caused by coronal mass ejections
International Solar workshop, ARIES, Nainital,
April 5-7, 2005.

Conferences Organized by the Centre

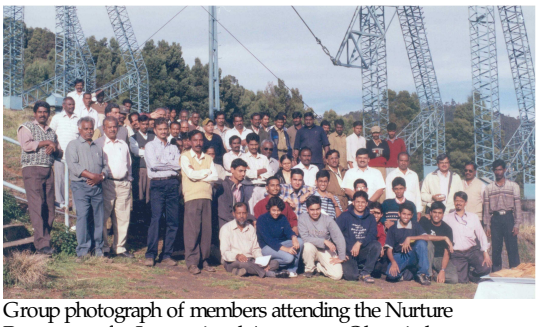
IHY Meeting

A national level workshop on 'India International Heliophysical Year (IHY) Planning', was organized at the Radio Astronomy Centre, during July 10–12, 2004. The workshop was attended by 30 members from various institute and universities. The outstanding issue discussed at the workshop was 'How to advance our understanding of heliophyical processes governing the influence of the Sun on the


A section of the audience attending IHY workshop at the RAC, Ooty.

Earth'. It was a brainstorming meeting and analysing in detail the scientific thrust to be targeted during IHY. During the workshop, six working groups were formed. Each working group contained scientists from different institutes and universities.

Nurture Programme for the Astronomy Olympiad



Group photograph of members attending the Nurture Programme for International Astronomy Olympiad.

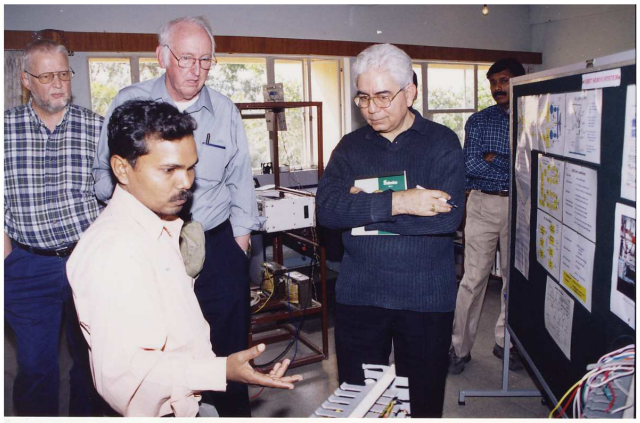
The First Nurture Programme for students who represented India at the International Astronomy Olympiad was conducted at Radio astronomy Centre from November 29 to December 5, 2004. Twelve students and six leaders participated in the programme. The students were divided into 4 groups and each group was given an observational project. Some of the results of these projects were prepared as posters for the ASI 2005.

Academia–Industry interaction meeting

A one-day meeting was held at GMRT on 19 June 2004 to explore the possibility of collaboration between GMRT and the Indian industry for the various electronic and software developmental activities taking place at GMRT. About 20 representatives from Software and Electronics industries in Pune and Bangalore were bussed to GMRT, Khodad, shown around the GMRT telescope and were given lectures on Radio astronomy, GMRT and the local development plans in the short and long term. This was followed by a group discussion where various aspects of such collaborations were discussed. It was highlighted that such collaboration was necessary if India wanted to play an active role in the building of the Square Kilometer Array.

An interactive session during the Academia–Industry interaction meeting at the GMRT Observatory, Khodad.

A review committee comprising Prof. W.A. Baan formerly of Westerbork Observatory, The Netherlands, Prof. P.K. Kaw, Director Plasma Research Institute, Gandhinarar (Convenor) and Prof. W.M. Goss former Director of VLA, USA, visited



The members of the NCRA Review Committee visiting one of the labs at the GMRT Observatory. From Left: Profs. Willem Baan, Prof. Miller Goss and P.K. Kaw.

NCRA Pune and the GMRT Observatory for five days during January 24–28, 2005. They have submitted a detailed report to the Director, TIFR, which is under consideration by the Council of Management.

FORSA Meeting:

Forum for Resource Sharing in Astronomy and Astrophysics (FORSA) meeting of all astronomy libraries from India during July 26–27 at NCRA, Pune and GMRT Observatory, Khodad.

Section 4: Publications

In Journals

P. Barai, Gopal-Krishna, M. A. Osterman and P.J. Wiita:
Expansion of Radio Galaxies in a Cosmologically Evolving Medium: Implications for the Cosmic Star-formation History
Bull. Astr. Soc. India, 32, 385, (2004)

Ayesha Begum, Jayaram N. Chengalur, Karachentsev, I. D. & Sharina, M. E.,
Resolving the mystery of the dwarf galaxy HIZSS003,
MNRAS, 359, 53L (2005).

Ayesha Begum, Jayaram N. Chengalur & I.D. Karachentsev:
A dwarf galaxy with a giant HI disk
A& A, 433, 1L (2005).

Poonam Chandra, Govind Swarup, Vasant K. Kulkarni, and Nimisha G. Kantharia:
Associated HI Absorption in the x=3.4 radio galaxy B2 0902+343 observed with the GMRT.
JAA, 25, 57, (2004)

Manojendu Choudhury and A.R. Rao:
Detection of an Anticorrelated Hard X-Ray Time Lag in Cygnus X-3,
ApJ, 616, L143 (2004)

M. Choudhury, A.R. Rao, S.V. Vadawale, A.K. Jain and N.S. Singh:
Binary corrected X-ray light curve of Cygnus X-3: Implications for the timing properties of the compact binary system
A& A, 420, 665 (2004)

Manojendu Choudhury and A.R. Rao:
Accretion-Ejection Mechanism of Cygnus X-3,
Progress in Theoretical Physics Supplement, 155, 321 (2004)

Gopal-Krishna, Samir Dhurde and Paul J. Wiita
Do the mildly Superluminal Radio Knots Exclude Extremely Relativistic Blazar Jets?
Astrophys. J. (Letters), 615, L81 (2004)

Gopal-Krishna, C.S. Stalin, Ram Sagar and P.J. Wiita:
Clear Evidence for Intranight Optical Variability of Radio-quiet Quasars
Astrophys. J. (Letters), 586, L25 (2003)

Gopal-Krishna, Paul J. Wiita and P. Barai
Low-level Radio Emission from Radio Galaxies and Implications for the Large-scale Structure
Journal of the Korean Astronomical Society, 37, 1 (2004)

Neeraj Gupta, R. Srianand and D.J. Saikia:
Outflowing material in the compact steep-spectrum source quasar 3C 48: evidence of jet-cloud interaction?
MNRAS, in press (2005)

G. Hobbs, A. Faulkner, I.H. Stairs, F. Camilo, R.N. Manchester, A.G. Lyne, M. Kramer, N. D'Amico, V.M. Kaspi, A. Possenti, M.A. McLaughlin, D.R Lorimer, M. Burgay, B.C. Joshi, F. Crawford,
The Parkes multibeam pulsar survey – IV. Discovery of 180 pulsars and parameters for 281 previously known pulsars,
MNRAS, 352, 1439, 2004.

Ananda Hota and D.J. Saikia:
A radio study of the superwind galaxy NGC 1482,
MNRAS, 356, 998 (2005)

S. Jeyakumar, P.J. Wiita, D.J. Saikia and J.S. Hooda:
Jet propagation and the asymmetries of CSS radio sources,
A& A, 432, 823 (2005)

B.C. Joshi, M.A. McLaughlin, A.G. Lyne, M. Kramer, D.R. Lorimer, R.N. Manchester, F. Camilo, B. Burgay, A. Possenti, N. D'Amico, P.C.C. Freire:
Double pulsar system J0737–3039 and its low-frequency observations with GMRT,
Bulletin of Astronomical Society of India, 32, 191, 2004.

C. Konar, D.J. Saikia, C.H. Ishwara-Chandra and V.K. Kulkarni:
Radio observations of a few giant sources,
MNRAS, 355, 845 (2004)

W. Kundt and Gopal-Krishna
The Physics of ExB Drifting Jets
JAA, 25, 115 (2004)

M.R. Kundu, S.M. White, V.I. Garaimov, P.K. Manoharan, P. Subramanian, S. Ananthakrishnan, P. Janardhan:
Radio Observations of Rapid Acceleration in a Slow Filament Eruption/Fast Coronal Mass Ejection Event,
ApJ, 607, 530, 2004.

A. Lecavelier des Etangs, Gopal-Krishna and F. Durret:
FUSE Search for the 10^5 – 10^6 K Gas in Clusters of Galaxies Abell 2029 and Abell 3112
A& A, 421, 503, (2004)

Dharam Vir Lal and A. Pramesh Rao,
3C 223.1: A source with unusual spectral properties
MNRAS, 356, 232, (2005)

R.N. Manchester, M. Kramer, A. Possenti, A.G. Lyne, M. Burgay, I.H. Stairs, A.W. Hotan, M.A. McLaughlin, D.R. Lorimer, G.B. Hobbs, J.M. Sarkissian, N. D'Amico, F. Camilo, B.C. Joshi, P.C.C. Freire,
The Mean Pulse Profile of PSR J0737–3039A
ApJ, 621, L49, 2005

P.K. Manoharan and M.R. Kundu:
Multi-wavelength study of a coronal mass ejection: a flare event from AR# 9393,
Advances in Space Research, 35, 70, 2005.

M.A. McLaughlin, M. Kramer, A.G. Lyne, D.R. Lorimer, I.H. Stairs, A. Possenti, R.N. Manchester, P.C.C. Freire, B.C. Joshi, M. Burgay, F. Camilo, N. D'Amico:
The Double Pulsar System J0737–3039: Modulation of the Radio Emission from B by Radiation from A,
ApJ, 613, L57, 2004

M.A. McLaughlin, A.G. Lyne, D.R. Lorimer, A. Possenti, R.N. Manchester, F. Camilo, I.H. Stairs, M. Kramer, M. Burgay, N. D'Amico, P.C.C. Freire, B.C. Joshi N.D.R. Bhat:
The Double Pulsar System J0737–3039: Modulation of A by B at Eclipse
ApJ, 616, L131, 2004

G. Michalek, N. Gopalswamy, A. Lara, and P.K. Manoharan:
Arrival time of halo coronal mass ejections in the vicinity of the earth,
A& A, 423, 729, 2004.

M. Pandey, R. K. Manchanda, P. Durouchoux, C. H. Ishwara-Chandra, A. Pramesh Rao,
GMRT observations of the field of INTEGRAL X-ray sources- I.
A& A, 2005, in press.

L. Resmi, C. H. Ishwara-Chandra, A. J. Castro-Tirado, D. Bhattacharya, A. Pramesh Rao, et. al.
Radio, Millimeter and Optical Monitoring of GRB030329 Afterglow: Constraining the Double Jet Model.
A& A, 2005, in press.

Kristine Spekkens, Judith A. Irwin, and D.J. Saikia:
H I in NGC 5433 and its environment: high-latitude emission in a small galaxy group,
MNRAS, 352, 1145 (2004)

D.J. Saikia:
Highlights from the Observatories,
BASI, 32, 133 (2004).

D.J. Saikia:
Highlights from the Observatories,
BASI, 33, 35 (2005).

D.J. Saikia, P. Thomasson, S. Roy, A. Pedlar and T.W.B. Muxlow:
Radio sources at low Galactic latitudes,
MNRAS, 354, 827 (2004)

C.S. Stalin, Gopal-Krishna, Ram Sagar and Paul J. Wiita:
Optical Variability Properties of High Luminosity AGN Classes,
JAA, 25, 1, (2004)

In Proceedings

Manojendu Choudhury and A.R. Rao:
X-ray Timing 2003: Rossi and Beyond
PhilipKaaret, Frederick K. Lamb, and Jean H. Swank (eds.), AIP Conference Proceedings, 714, 120 (2004)

M. Choudhury and A.R. Rao:
Compact Binaries in the Galaxy and Beyond
IAU Cdloquium194, G. Tovmassian and E. Sion (eds.), Revista Mexicana de Astronoma y Astrofsica (Serie de Conferencias), 20, 203 (2004)

R.D. Ferdman, I.H. Stairs, D.C Backer, R. Ramachandran, P. Demorest, D.J. Nice, A.G. Lyne, M. Kramer, D. Lorimer, M. McLaughlin, D. Manchester, F. Camilo, N. D'Amico, A. Possenti, M. Burgay, B.C. Joshi, P.C.C. Freire:
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C.H. Ishwara-Chandra, A. Pramesh Rao, M.D. Pandey, R.K. Manchanda, P. Durouchoux:
The fifth microquasar workshop: Microquasars and related astrophysics,
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C.H. Ishwara-Chandra and A. Pramesh Rao:
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Dharam Vir Lal and A. Pramesh Rao:
Low frequency radio morphology of head-tail radio sources in the Perseus cluster,
to appear in ASP Conference Series (From Clark Lake to the Long Wavelength Array: Bill Erickson's Radio Science)

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A.R. Maloney, C.L.M. Williams, R.W. Romani, M.S.E. Roberts, B.C. Joshi, S. Ransom:
GMRT Imaging/Pulse Studies of Unidentified EGRET Sources,
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A. Possenti, M. Burgay, N. D'Amico, A. Lyne, M. Kramer, M. McLaughlin, D. Lorimer, R.N. Manchester, F. Camilo, J. Sarkissian, P.C.C. Freire, B.C. Joshi:
The Double Pulsar binary J0737–3039: a two-clocks relativistic system
AIP Conf. Proc. 751: General Relativity and Gravitational Physics: p. 126, 2005

In Technical / Internal Reports

Dharam Vir Lal, Ishwara-Chandra and A. Pramesh Rao:
The GMRT Antenna Pointing – I. Calibrating the FPS Positions.
January 2005, R00216

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The GMRT Antenna Pointing – Understanding the Elevation Offsets as a Function of Hour Angle of the Source.
January 2005, R00217

J. Roy, T.L. Venkatsubramani and B.C. Joshi
Phase Stability and GMRT's Frequency Standard,
NCRA Technical Report R00211, 2004

N. Udaya Shankar, and S. Ananthakrishnan:
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Part 5: Lectures & Graduate School Programmes

Lectures / Lecture Courses Given Elsewhere

S. Barve

Internet search engines: boosting the Internet information retrieval with search strategies — A tutorial
7th National Convention on Library and Information Networking, University of Pune
November 23–26, 2004.

M. Choudhury

Hard X-ray and Soft Gamma Ray properties of Cosmic Sources
Thesis talk at 23rd ASI Meeting, Nainital,
February 17-21, 2005.

Gopal Krishna

Radio Galaxies and the Evolution of the Universe
Bordeaux Observatory
December 16, 2004

Highlights of Radio Astronomy
Two lectures, ARIES, Nainital
October 2004.

Science with GMRT
Two lectures at Osmania University
February 2005

B.C. Joshi

Compact Objects,
IUCAA–NCRA VSP/VSRP and Summer School 2004, IUCAA, Pune
May 24 – 25, 2004

Coherent Online Baseband Receiver for Radio Astronomy (COBRA): A Parallel processing Beowulf Cluster for Pulsar Observations
Workshop on High Performance Computing, IUCAA, Pune
October 6, 2004

COBRA: A parallel processing Beowulf cluster for Pulsar Observations,
Department of Electronics and Computer Engineering, Indian Institute of Technology, Roorkee
September 13, 2004

A Unique Celestial Laboratory for Relativistic gravity and Plasma Physics — The First Double pulsar J0737–3039
Department of Physics, Indian Institute of Technology, Roorkee
September 14, 2004

Beowulf Clusters and Radio Astronomy,
Pune Institute of Computer Technology, Pune
March 19, 2005

R. Nityananda

High ambitions at low frequencies: The GMRT and beyond
Indian Academy of Science, Banaras Hindu University, Varanasi,
November 26, 2004.

Geometry of Polarised Light
Chief Guest's address for the prize distribution function to the Indian National Mathematical Olympiad 2005, Bhaskarharya Pratishthana, Pune
March 26, 2005.

Einstein's quest for light
Academy of Physics Teachers, Science College, Trivandrum
February 15, 2005.

A. Pramesh Rao

Science with GMRT,
CEA, Saday, France,
July 2004

Radio Techniques and GMRT
2 lectures to Astronomy students at ARIES,
September, 2004

D.J. Saikia

Active Galactic Nuclei (2 Lectures)
IUCAA-NCRA Summer school, IUCAA
June 2004.

Lectures by Visitors

Astronomy & Instrumentation Seminar

A. Sengupta, NPL, Delhi:
Building a Hydorgen Maser Standard,
April 19, 2004

Manojendu Choudhury, TIFR, Mumbai:
Accretion-ejection mechanism in Galactic micro-quasars,
May 28, 2004

Sushan Konar, IIT, Kharagpur:
Multipolar Magnetic Fields of Pulsars,
June 11, 2004

Judith Irwin, Queen's University, Kingston, Canada:
The Disc-Halo Connection in Galaxies,
June 23, 2004

Y.C. Minh, Korea Astronomy Observatory, South Korea:
Chemical Properties of Molecular Cloud in our Galactic Center,
July 2, 2004

Indranil Chattopadhyay, Centre for Plasma Astrophysics, Deptt of Mathematics, K.U.Leuven, Belgium
Radiotively Driven Jets from TCAF Accretion Disc,
July 2, 2004

Paul.J. Wiita, Georgia State University, Atlanta:
Combined Radio and Optical Properties of Extragalactic Radio Sources,
July 5, 2004

P. Barai, Georgia State University, Atlanta, USA:
Cosmological Evolution of FRII Radio Sources,
July 9, 2004

Amit Acharyya, National Institute of Technology, Burdwan University, Durgapur:
Low Frequency Shape of Pulsars Beams,
July 15, 2004

David Green, MRAO, Cambridge, UK:
The Crab Nebula: 950 years old. New sub-mm and infrared observations,
July 29, 2004

Nick Seymour, Institut d'Astrophysique de Paris:
The Nature of the Faint SubmJy Radio Population,
August 10, 2004

Ashish Asgekar, RRI, Bangalore:
A Search for Narrow Vertical Structures in the Canadian Galactic Plane Survey,
August 23, 2004.

Sabyasachi Pal, Centre for Space Physics, Kolkata:
Results of Recent Multi-Wavelength Campaigns of SS433,
August 30, 2004.

Roy J M Smits, University of Nijmegen, Holland:
Probing the radio-active zones of pulsar B0031-07 through its drifting subpulses,
September 17, 2004.

S. Sarala, IIT, Kanpur:
Study of Radio and Optical Polarization Anisotropies in the Electromagnetic waves from Extragalatic Sources,
September 24, 2004.

Jonathan Braine, Observatorie de Bordeaux, France:
Tidal Dwarf Galaxies: Ongoing Galaxy Formation,
October 8, 2004.

P.A. Fridman, ASTRON, Netherlands:

RFI Mitigation: Algorithms and test measurements,
November 2, 2004.

P.A. Fridman, ASTRON,Netherlands:

RFI Mitigation: Algorithms and test measurements and preliminary results from GMRT,
November 11, 2004.

S. Jeyakumar, Raman Research Institute, Bangalore:

Ultra Compact H II Regions: Modelling of Carbon Recombination Line Emission,
November 22, 2004.

Bhuwan Joshi, ARIES, Nainital

Intermediate-term periodicity in solar activity
November 22, 2004, RAC Lecture Hall.

M. Kesteven, ATNF, Australia:

RFI mitigation for pulsar observation,
December 3, 2004.

C.H. Ishwara Chandra,

Inputs from the preparatory meeting on Search for Radio Emission from Extra-solar Planets

Kajari Mazumdar, Experimental High Energy Physic Group, TIFR, Mumbai:

Yesterday's Discovery is Today's Signal and Tomorrows Background!,
February 11, 2005.

Phillippe Durouchoux, CEA Sadaysevice d' Astrophysique, France:

New Science and Technology at the dawn of the XXIst Century,
March 3, 2005.

Students Seminar

Ayesha Begum:

Study of Faint Dwarf Galaxies,
June 14, 2004.

Chiranjib Konar:

Giant Radio Sources,
June 14, 2004.

Bhaswati Bhattacharya:

Characteristic Single Pulse Characteristics of Pulsars using GMRT:
June 14, 2004.

Ananda Hota:

Activity and Outflows in Galaxies,
June 14, 2004.

Neeraj Gupta:

Circumnuclear gas in Radio Galaxies,
June 18, 2004.

Mamta Pandey:

Microquasars and INTEGRAL sources,
June 14, 2004.

Sandeep Sirothia:

Radio Continuum Survey of The Sky At 233 MHz using GMRT: Status Report,
March 21, 2005.

Graduate Courses

Gopal Krishna
Extragalactic Astronomy (Part II)

R. Nityananda
Electrodynamics and Quantum Mechanics

D.J. Saikia
Introductory Astronomy and Astrophysics

Interstellar medium

Ph.D. Theses / M.Sc. Theses

R. Nityananda

Externally examined the thesis "Instability and turbulence in certain astrophysical flows" by Arnab Kumar Ray, Jadavpur Univesity, Kolkata.

VSRP Projects / Training of College Students

Sayali S. Avachat, Department of Physics, University of Pune:
Radio interferometry and imaging,
(Guides: D.J. Saikia and Vasant K. Kulkarni)

J. Hariharan, University of Madras, Tamilnadu:
Non-thermal halos in galaxies
Guide: D.J. Saikia

Theju Isabelle Jacob, MES College of Engineering, University of Calicut, Kerala:
Polarimetric Observations of Pulsars
Guide: B.C. Joshi

S. Murugan: Spectral study of a few extragalactic sources, VSRP Project
Guide: N.G. Kantharia

Ritu Pasrija, Punjab University, Chandigarh:
Review of Algorithms for Pulsar Searches
Guide: B.C. Joshi

Sunil Ramakrishnan, International Institute of Information Technology (I^2IT), Pune:
Software Based Receiver for Pulsars
Guide: B.C. Joshi

Felicia A.E. Robert, Madras Christian College, Tamilnadu:
Giant radio sources
Guide: D.J. Saikia

Monark Trivedi, Sardar Patel University, Gujarat:
Microquasars
Guide: D.J. Saikia

About 80 students [B.E., M.Sc. (Physics), B.Sc.(Physics)] from various engineering and science colleges all over Tamil Nadu attended the implant training programme conducted at RAC, during May 23 - 29, 2004.

About 90 batches of students (electronics, electrical and computer science department students) visited RAC on educational tour. Each batch contained about 50 to 60 students.

Popular Science Articles / Lectures

A. Pramesh Rao and S. Ananthakrishnan:
Giant Metrewave Radio Telescope,
Khagol Newsletter, IUCAA, 2004

B.C. Joshi

It takes two to tango … — A tale of binary stars
Indian Institute of Technology, Roorkee
September 13, 2004

P.K. Manoharan

Use of Internet in education
Vivekananda Memorial Matriculation School, M. Palada, Nilgiris,
April 8, 2004.

Sun – Earth Connections
Nilgiris Environment Association, Ooty
August 27, 2004.

Careers in Astronomy and Astrophysics
CSI College of Engineering, Ketti, Nilgiris
November 5, 2004.

Science Awareness
TamilNadu Science Forum Meeting, Bethlehem Teacher Training Institute,
Ooty,
December 23, 2004.

R. Nityananda

The GMRT: Telescope and Sky,

Lecture for the Astronomy Olympiad Camp at the GMRT Observatory, Khodad

May 7, 2005

Einstein's contributions to statistical physics

Indian planetary society, Mumbai

January 7, 2005.

Special Theory of Relativity — Applications

Seminar on Completion of 100 years of Discovery of Special Theory of Relativity

Annasaheb Waghire College, Otur, Tal: Junnar, Pune

March 7, 2005.

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