National Centre for Radio Astrophysics

NCRA • TIFR

Annual Report – 2009 - 2010

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SOLAR SYSTEM: SUN AND SOLAR WIND

Evolution of Near-Sun Solar Wind Turbulence:

The preliminary study of the turbulence spectrum of the solar wind in the near-Sun region (R < 50 Run) has been made. The data sets for this study have been obtained from interplanetary scintillation measurements with the ORT at 327 MHz. The results clearly show that the scintillation is dominated by density irregularities of size about 100 − 500 km. The scintillation at the small-scale side of the spectrum, although significantly less in magnitude, has a flatter spectrum than the larger-scale dominant part. Furthermore, the spectral power contained in the flatter portion rapidly increases closer to the Sun. These results on the turbulence spectrum for R < 50 Rsun quantify the evidence for radial evolution of the small-scale fluctuations (≤ 50 km) generated by Alfven waves. *[P.K. Manoharan]*

From Sun to Earth of May 13, 2005, Coronal Mass Ejection

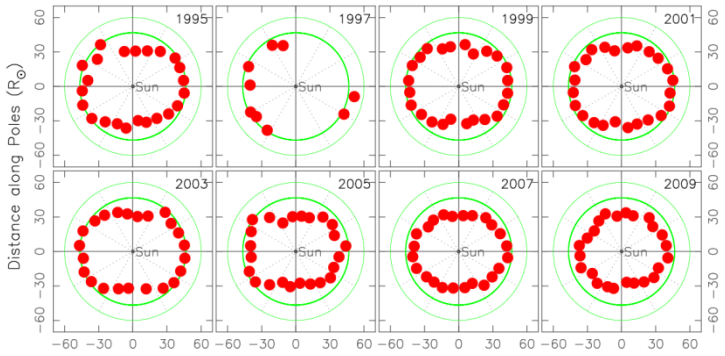
A multi-instrument, multi-technique, coordinated study of the solar-eruptive event of 13 May 2005 has been made. The CME associated with this event impacted the Earth's magnetosphere and caused the most-intense geomagnetic storm of 2005 with a Disturbed Storm Time (Dst) index reaching -263 nT at its peak. This study significantly highlights the importance of observations of interplanetary scintillation (IPS) and shows the grand-scale propagation of the ICME through the interplanetary medium, its changing structure and distribution in the heliosphere. It also gives the insight into the relatively-large non-radial poleward flows of the fast wind to the north as a result of the CME's passage allowing us to look at the interaction between a traveling ICME and the background solar wind more closely than any other method currently available. The picture which has emerged from this study is the CME event is much more complex one, with a significantly asymmetric structure which, in turn, is probably important in governing its effects on the space environment of Earth. *[P.K. Manoharan, with M. Bisi, K. Agalya, and several others]*

Peculiar Current Solar-Minimum Structure of the Heliosphere:

The three-dimensional evolution of the inner heliosphere over the solar cycle #23 has been studied based on observations of interplanetary scintillation (IPS) made at 327 MHz using the Ooty Radio Telescope. The large-scale features of solar wind speed and density turbulence of the current minimum are remarkably different from that of the previous cycle. The results are consistent with the magnetic-field strength at the poles and the warping of heliospheric current sheet. The results on solar wind density turbulence show that (1) the current solar minimum is experiencing a low level of coronal density turbulence, (2) the scattering diameter of the corona has decreased steadily starting from year 2003, i.e.,

during the declining phase of the activity, and (3) the turbulence at a given distance in the heliosphere, irrespective of latitude, has remained nearly at the same level between years 1989 and 2003, but decreased steadily after 2003 to a current value of ~50% at the equatorial region. The current solar cycle minimum seems to have peculiar properties that are likely related to weak magnetic fields. These results suggest that the source of solar wind changes globally, with the important implication that the supply of mass and energy from the Sun to the interplanetary space has significantly reduced in the present low level of activity. *[P.K. Manoharan]*

A large amount of interplanetary scintillation (IPS) data obtained from the Ooty Radio Telescope has been employed to study the three-dimensional evolution of density turbulence in the heliosphere. Shape of the three-dimensional contours of constant density turbulence in the solar wind, obtained from the Ooty IPS measurements. Compared to years between 1995 and 2003, in the current minimum, the contours gradually shrink close to the Sun, indicating decrease in the scattering diameter of the solar corona. The observed features and the prolonged peculiar minimum are possibly linked to the changes in the flux-transport dynamo. *[P.K. Manoharan]*



3-D Reconstructions of November 2004 Geomagnetic storms: Analysis of Ooty IPS Speed and Density Structures:

The time-dependent model used with the IPS observations made with the ORT allows the tomographic reconstruction of the three-dimensional heliospheric density and speed in the distance range of 0.1 – 3 AU. The Ooty IPS observations provide the digital resolution of the tomography of 10 degree by 10 deg . The reconstructed structures have been compared with the in-situ measurements. In particular, the reconstruction agrees well with in-situ measurements during the high solar activity observed at the early part November 2004 from the Wind spacecraft orbiting the Sun-Earth L1 Point. *[P. K. Manoharan with M. Bisi , B. V. Jackson, J. M. Clover, M. Tokumaru, P. P. Hick and A. Buffington]*

Evolution of Solar Magnetic Field and Associated Multiwavelength Phenomena:

Flare events (M1.4/1N and M9.6/2B) on 2003 November 20 in the active region NOAA 10501 have been studied using Halpha images, soft X-ray profiles, magnetograms, extreme ultra-violet images and, radio observations. It provides the properties of reconnection between twisted filament systems, energy release,

and associated launch of coronal mass ejections. During both events twisted filaments observed in Halpha approached each other and initiated the flare processes. However, the second event showed the formation of cusp as the filaments interacted. The rotation of sunspots of opposite polarities, inferred from the magnetograms likely powered the twisted filaments and injection of helicity. Along the current sheet between these two opposite polarity sunspots, the shear was maximum, which could have caused the twist in the filament. At the time of interaction between filaments, the reconnection took place and flare emission in thermal and non-thermal energy ranges attained the maximum. The radio signatures revealed the opening of field lines resulting from the reconnection. The Halpha images and radio data provide the inflow speed leading to reconnection and the scale size of the particle acceleration region. The first event produced a narrow and slow CME, whereas the later one was associated with a fast full halo CME. The halo CME signatures observed between the Sun and Earth using white-light and scintillation images and in situ measurements indicated the magnetic energy utilized in the expansion and propagation. The magnetic cloud signature at the Earth confirmed the flux rope ejected at the time of filament interaction and reconnection. *[P. K. Manoharan with Pankaj Kumar and Wahab Uddin]*

BASIC PHYSICS

Fundamental constant evolution with conjugate satellite OH lines:

Observations of the redshifted satellite OH 18cm lines at z ~ 0.247 towards PKS1413+135 were carried out with the Westerbork Synthesis Radio Telescope and the Arecibo Telescope. The "conjugate" nature of these lines, with one line in emission and the other in absorption, but with the same shape, implies that the lines arise in the same gas. The satellite OH 18cm line frequencies have different dependences on the fine structure constant α, the proton-electron mass ratio $\mu = m_p/m_e$, and the proton gyromagnetic ratio g_p. Comparisons between the satellite line redshifts in conjugate systems can hence be used to probe changes in α, μ and g_p with few systematic effects. The technique yields the expected null result when applied to Cen.A, a nearby conjugate satellite system. For the z ~ 0.247 system towards PKS 1413+135, combining results from the two telescopes yields $[\Delta G/G] = (-1.18 \pm 0.46) \times 10\text{-}5$ (weighted mean), where $G = g_p[\mu\alpha^2]^{1.85}$; this is tentative evidence (with 2.6σ significance, or at 99.1 % confidence) for a smaller value of α, μ , and/or g_p at z~ 0.247, i.e. at a lookback time of ~2.9 Gyrs. Assuming that the dominant change is in α, this implies $[\Delta\alpha/\alpha] = (-3.1 \pm 1.2) \times 10\text{-}6$. No evidence is found that the observed offset might be produced by systematic effects, either due to observational or analysis procedures, or local conditions in the molecular cloud. *[Nissim Kanekar and Jayaram N. Chengalur with Tapasi Ghosh]*

Fundamental constant evolution with neutral gas lines:

Narrow HI-21cm and ultra-violet CI absorption were detected at z ~1.4 – 1.6 towards Q0458-020 and Q2337-011, and these lines used to test for possible changes in the fine structure constant α, the proton-electron mass ratio μ, and the proton gyromagnetic ratio g_p. A comparison between the HI-21cm and CI line redshifts yields $\Delta X/X = [+6.8 \pm 1.0] \times 10^{-6}$ over $0 < z < 1.46$, where $X = g_p\alpha^2/\mu$, and the errors are purely statistical, from the gaussian fits. The simplicity of the line profiles and the high sensitivity of the spectra imply that the statistical errors in this comparison are an order of magnitude lower than in previous studies. Further, the CI lines arise in cold neutral gas that also gives rise to HI-21cm absorption, and both background quasars are core-dominated, reducing the likelihood of systematic errors due to local velocity offsets between the hyperfine and resonance lines. The dominant source of systematic error lies in the absolute wavelength calibration of the optical spectra, which appears uncertain to ~2 km/s, yielding a maximum error in $\Delta X/X$ of ~ 6.7×10^{-6}. Including this, the result $\Delta X/X = [+6.8 \pm 1.0(\text{statistical}) \pm 6.7(\text{max.systematic})] \times 10^{-6}$ over $0 < (z) < 1.46$ was obtained. This is inconsistent with earlier claims of a smaller value of α from the many-multiplet method, unless fractional changes in g_p are larger than those in α and μ . *[Nissim Kanekar and Jayaram N. Chengalur with Jason X. Prochaska and Sara Ellison]*

OUR GALAXY

A search for the 55 MHz OH lines:

The occurrence of the massed 53/55 MHz M1 transition of the OH ground rotational state (J=3/2) can be translated into conditions on the level populations of the ground state 18cm OH lines. Briefly, the satellite lines - 1720 MHz and 1612 MHz - respectively, should be mased and thermal. Depending on which of the main lines - 1665 MHz and 1667 MHz - is mased and the other thermal, either of the 53 or 55 MHz lines could be excited. Based on such conditions, we had identified a few candidate regions in the Galactic plane where the 53 / 55 MHz lines could arise. The four experimental, low-frequency feeds designed and developed by the Raman Research Institute were used to observe the regions, to search for the OH 54 MHz lines. The new GMRT Software Backend (GSB) was used in a special mode to record the data. Though the 55 MHz line was not detected to a limit of 4σ, the research has led to a revised upper limit on the amplification factor for the line. [*V. R. Marthi and J. N. Chengalur]*

Fine Structure in the Galactic ISM:

The angular power spectrum of HI 21 cm opacity fluctuations is a useful statistic for quantifying the observed opacity fluctuations as well as for comparing these with theoretical models. The HI 21cm opacity

fluctuation power spectrum towards the supernova remnant Cas A from GMRT interferometric data with spacial resolution of 5arcsec and spectral resolution of 0.4 km s-1 was computed. The power spectrum has been estimated using a simple but robust visibility-based technique. We find that the power spectrum is well fitted by a power law $P(U) = U^{\alpha}$ with a power-law index of α= -2.86 +/- 0.10 (3sigma error) over the scales of 0.07-2.3 pc for the gas in the Perseus spiral arm and 0.002-0.07 pc (480-15730 au) for that in the local arm. There is no statistically significant change in the power-law index with the velocity width of the frequency channels. This constrains the power-law index of the velocity structure function to be beta = 0.2 +/- 0.6 (3sigma error). *[Nirupam Roy and Jayaram Chengalur with Prasun Dutta, Somnath Bharadwaj]*

Radio Study of unidentified VHE Gamma Ray Source with GMRT:

MGRO J2019+37 is an unidentified source of very high energy gamma-rays and is the brightest TeV source in the Cygnus region. It is not known whether this object is an extended source or a superposition of point-like TeV sources. With an aim to identify potential radio and infra-red counterparts, we have observed this unidentified very high energy source with GMRT at 610 MHz and in infra-red K-band on 3.5m telescope at Calar Alto, Spain. A few peculiar sources are seen within the error circle which are being further studied to ascertain its relation to the VHE Gamma Ray source *[C. H. Ishwara Chandra with J. M. Paredes, J. Marti and 10 collaborators]*.

Explaining the outbursts from the Galactic centre radio transient J1745-3009.

The circularly polarised outbursts detected from a reanalysis of its September 2003 rediscovery data as well as earlier published total intensity detections at 325 MHz from the above radio transient could be explained as outbursts from a highly subsolar (~0.1 Msun) magnetically dominated dwarf star at a distance of <=4 kpc. *[Subhashis Roy]*

SEGUE: A Spectroscopic Survey of 240,000 Stars with g = 14 – 20:

The Sloan Extension for Galactic Understanding and Exploration (SEGUE) Survey obtained ~240,000 moderate-resolution (R ~1800) spectra from 3900 Å to 9000 Å of fainter Milky Way stars ($14.0 < g < 20.3$) of a wide variety of spectral types, both main-sequence and evolved objects, with the goal of studying the kinematics and populations of our Galaxy and its halo. The spectra are clustered in 212 regions spaced over three quarters of the sky. For stars with signal-to-noise ratio> 10 per resolution element, stellar atmospheric parameters were estimated, including mutuality, surface gravity, and effective temperature. The stellar spectra, imaging data, and derived parameter catalogs for this survey have been publicly released as part of the Sloan Digital Sky Survey Data Release 7. *[Yogesh Wadadekar with the SEGUE collaboration]*

PULSARS

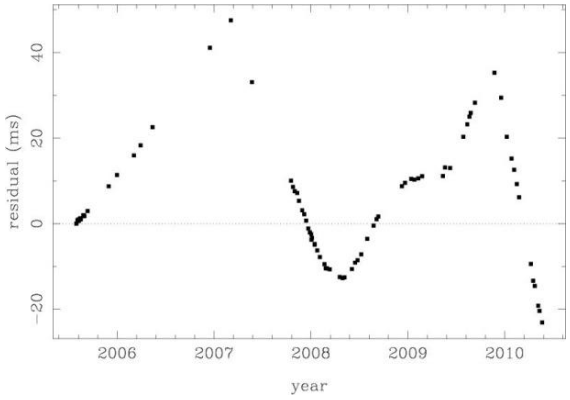
Unique nulling properties of PSR B0818-41 :

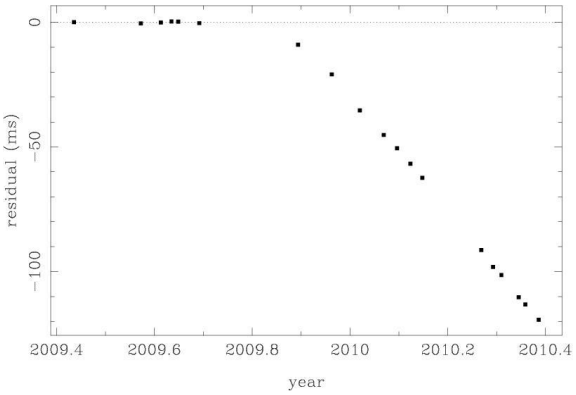
Wide profile pulsars give us an unique opportunity to probe detailed emission properties of radio pulsars. One such pulsar is PSR B0818-41 whose unique sub-pulse properties have been reported by us in the past. We have now looked closely at the nulling behaviour of this pulsar, using GMRT data at 325 and 610 MHz, and discovered a very interesting pattern wherein the pulsar, which has a nulling fraction of 30% at 325 MHz, shows systematic variations of pulse intensity and sub-pulse drift behaviour just before and just after the nulls. We find that the pulsar's intensity does not switch off abruptly at the null, but fades gradually, taking ~ 10P1. On the other hand, just after the nulls the intensity rises to a maximum over a short (less than one period) time scale, and then decays to the average value within a few pulses. In addition, there are subtle changes in the shape of the emission profile for the first few active pulses after the nulls. Furthermore, just before the onset of the nulls, for about 60% of the occasions, the rate of drift of the subpulses is observed to become slower (correlated with the gradual decrease of pulse intensity), transitioning to an almost phase stationary drift pattern. In contrast, when the pulsar comes out of the null the increased intensity is very often accompanied by what looks like a disturbed drift rate behaviour, which settles down to the regular drift pattern as the pulsar intensity returns to normal. The repeatibility of the behaviour when the pulsar emerges from the null is found to be quite remarkable and leads us to infer that there is some kind of "reset" of the pulsar radio emission engine during the null. Using the partially screened gap model for pulsar emission, we are able to explain some aspects of the interesting nulling behaviour of this pulsar. *[B. Bhattacharyya and Yashwant Gupta with J. Gil]*

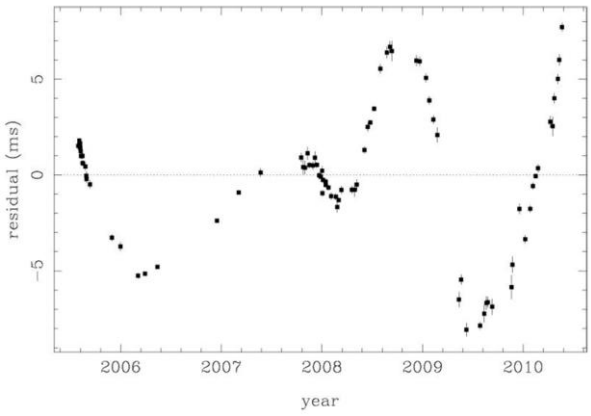
Timing of pulsars :

Further new results were obtained from over 4 years of timing study of the young pulsar J1833-1034 in the supernova remnant G21.5-0.9. This pulsar, discovered with the GMRT in 2005, has been regularly timed with the GMRT at 610 MHz to monitor the occurrence of glitches -- a phenomenon where there is a sudden spin-up or increase in the rotation frequency of the pulsar. As many as 4 glitches have been clearly detected in the timing data, over a period of about 4 years. The fractional change in rotation frequency (delta f / f) in these glitches ranges from 1×10^{-9} to 3×10^{-9}, and there is no evidence for any appreciable relaxation of the rotational frequency after the glitches. The pulsar rotational frequency, as well as its first and second derivatives, are found to be fairly constant over the full data set, and yield a plausible value for the breaking index of about 2.16 +/- 0.001.

This pulsar appears to show fairly frequent occurrence of low amplitude glitches, and estimates of its glitch activity parameter put it in a regime very similar to the Crab pulsar, and very different from other glitching pulsars. Along with the observations of the control pulsars, these long duration observations of J1833-1034 have demonstrated the capability of the GMRT to carry out fairly sensitive timing observations. *[Jayanta Roy and Yashwant Gupta with W. Lewandowski]*







1. Timing discontinuities at the epochs 2007.2, 2007.9, 2008.8 and 2009.9, seen as sudden changes in the slope of the residuals, are manifestations of glitches *(Fig .at top left)*

2. Close-up view of one of the glitches : Timing residuals for a local phase-connected timing solution near the epoch of the fourth glitch. The sharp deviation of the residuals just after 2009.9 is characteristic of a glitch that produces a sudden spin-up in the pulsar rotational rate. *(Fig. at top)*

3. The timing residuals after modeling for all the 4 glitches in the data, showing a significant reduction in the rms deviation of the residuals. The smooth fluctuations that remain are likely to be intrinsic timing noise of this young pulsar. *(Fig. at bottom left)*

Understanding emission profiles : the effects of pulsar rotation and geometry

Further results have been obtained from the new method that has been developed to locate the possible emission regions in pulsar magnetospheres, taking into account detailed effects of geometry and rotation of the neutron star. Earlier, it had been shown clearly that significant asymmetries in the profiles can be produced by rotation effects. Detailed investigations have been carried out on the dependency of the profile features on various pulsar parameters. We find that discrete heights of emission along discrete sets

of field lines are required to reproduce realistic pulsar profiles, including asymmetires between leading and trailing components, and this has been illustrated by successful application to the profile of one pulsar, at three different frequencies. We are also able to show how core emission and one-sided cones result naturally from this method of modeling pulsar emission properties. *[R. M. C. Thomas and Yashwant Gupta, with R. T. Gangadhara]*

GMRT Galactic Plane Pulsar and Fast Transients Survey:

GMRT Galactic Plane Pulsar and Fast Transients Survey is a successor survey to GMRT Long Period Pulsar Survey, which was was the first blind survey of the north Galactic plane. It covers a region of sky between Galactic longitude $45^o < l < 135^o$ and Galactic latitude $|b| < 10^o$ using the GMRT at 325 MHz. Observations for about 10 percent of the survey were carried out in July and December 2009. 15 known pulsars have been detected in the data processed so far, consistent with predictions from pulsar population models. A few promising candidates have also resulted from the processing of the data, which is continuing using a 72-node high performance cluster located at NCRA. *[B. C. Joshi with M. A. McLaughlin, M. Surnis, C Prasad, V. Gajjar, D. R. Lorimer, M. Kramer, A. G. Lyne, D. A. Ludovici]*

A survey of nulling pulsars with the GMRT:

Several pulsars show sudden cessation of pulsed emission, which is known as nulling. A systematic survey to study nulling in pulsars is being carried out at 325 and 610 MHz with he GMRT. Eleven known pulsars, which show nulling, were observed. Eleven new pulsars, discovered in the Parkes multi-beam survey, were also observed as part of this survey. The average profiles for some of these new pulsars have been obtained for the first time at such low frequencies. The nulling fraction for eighteen of these pulsars were estimated from the data and these range from a few percent to about 90 percent. The ratio of pulse energy in the burst pulses to that in the nulled pulses were also estimated for these eighteen pulsars, with the highest ratio of about 658 seen in PSR B1112+50. Interesting nulling and drifting behaviour was also observed for PSR B2319+60 with two prominent drift modes interspersed with nulls *[Vishal Gajjar and Bhal Chandra Joshi with M. Kramer]*

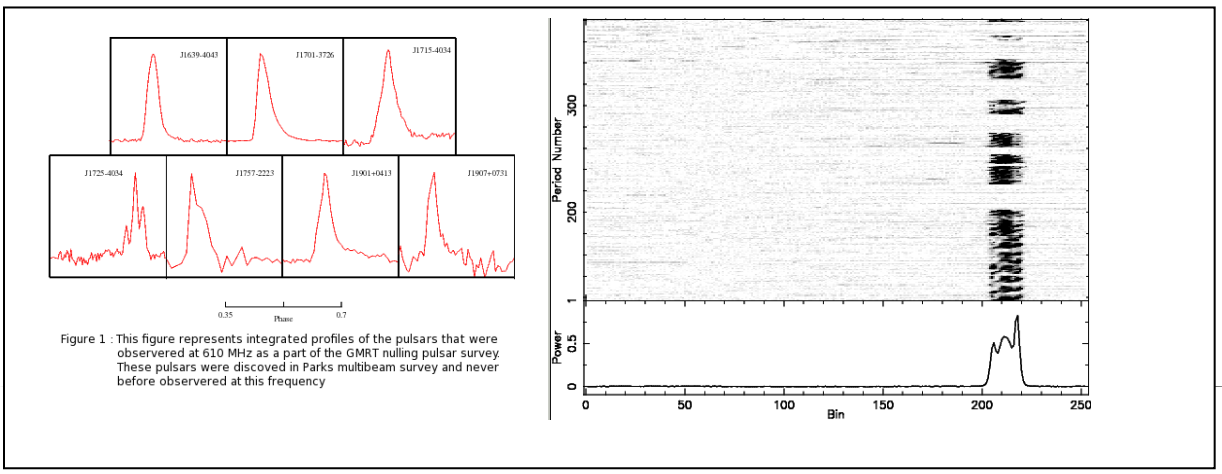


Figure 1 : This figure represents integrated profiles of the pulsars that were observered at 610 MHz as a part of the GMRT nulling pulsar survey. These pulsars were discoved in Parks multibeam survey and never before observered at this frequency

Absolute emission heights of pulsars emission spots:

We have estimated the emission height of the core components, and hence found the absolute emission altitudes corresponding to the conal components of the pulsars PSRs ~ B1839+09, B1916+14 and B2111+46. Our findings indicate that the emission beams of these pulsars have the nested core—cone structures. By employing the aberration retardation techniques we have been able to locate the phase location of the meridional plane and to estimate the absolute emission altitude of both the core and the conal components relative to the neutron star center, using the exact expression for the A/R phase shift. *[Reji Mathew C. Thomas with R.T. Gangadhara]*

A search for pulsars orbiting the Galactic Centre black hole:

A deep high-frequency search for pulsars within the central parsec of SgrA* was carried out with the Green Bank Telescope. The observing frequency of 15 GHz was chosen to maximize the likelihood of detecting normal pulsars (i.e. with periods of ~500 milli-seconds and spectral indices of ~ −1.7) close to SgrA*, that might be used as probes of gravity in the strong-field regime. This is the highest frequency used for such pulsar searches of the Galactic Centre to date. No convincing candidate was detected in the survey, with a 10σ detection threshold of ~ 10 micro-Jy achieved in two separate observing sessions. This survey represents a significant improvement over previous searches for pulsars at the Galactic Centre and would have detected a significant fraction (≥ 5%) of the pulsars around SgrA*, if they had properties similar to those of the known population. Based on the best current knowledge of the properties of the Galactic pulsar population and the scattering material toward SgrA*, the results place an upper limit of 90 normal pulsars in orbit within the central parsec of SgrA*. *[Nissim Kanekar with J-P. Macquart, Dale Frail and Scott Ransom]*

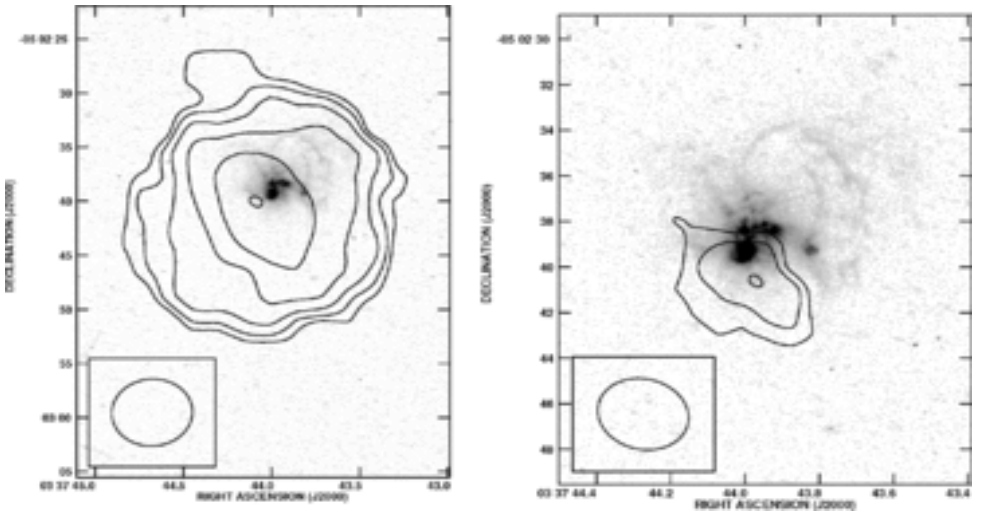
NORMAL GALAXIES

Extremely metal deficient galaxies:

We analysed GMRT HI data of two extremely metal-deficient (XMD) galaxies, viz., UM 133 and SDSS J011914.27-093546.4, with no known nearby companions. Earlier HI observations of XMD galaxies have shown that disturbed HI morphologies and kinematics, generally related to tidal interaction with a companion, are common in them. However, some of these galaxies were already known to be in pairs, before the HI observations. The two galaxies were specifically selected not to have any known nearby companions. None the less, we found that both galaxies have highly disturbed HI morphologies and velocity fields. These could have arisen from interactions with more distant companions than considered in our isolation criteria, or merger with extremely gas-rich dwarf companions. Our observations provide

support to the idea that inflow of metal-poor gas, from the outskirts of a galaxy to the central star-forming regions is the probable cause for the observed low emission-line metallicities of XMD galaxies. *[B. Ekta & Jayaram N. Chengalur]*

Giant Metrewave Radio Telescope, HI 21 cm observations were made of SBS 0335-052E and SBS 0335-052W, a close pair of dwarf galaxies, which are further unusual in being the most metal-poor star-forming galaxies known. The images show that SBS 0335-052 is a strongly interacting system, with a faint diffuse HI bridge seen at low resolution, and elongated tails seen at the higher resolutions. The overall morphology suggests that the pair represents a major (as both galaxies have similar HI masses) merger of extremely gas-rich galaxies, which is currently past the first close encounter. The two galaxies have very similar HI masses, but very different optical properties and current star formation rates. A possible reason for this is the differing amounts of tidally induced star formation, because of the different spin orientations of these interacting galaxies. The highest angular resolution HI images show that the ionized superbubble, identified by Thuan, Izotov & Lipovetsky, in the Hubble Space Telescope images of SBS 0335-052E, is extended along one of the diffuse tidal features, and that there is a high-density HI clump at the other end of the superbubble. The star formation in SBS 0335-052E occurs mainly in a group of superstar clusters (SSCs) with a clear age gradient; the age decreases as one approaches the dense HI clump. It is suggested that this propagating star formation is driven by the superbubble expanding into a medium with a tidally produced density gradient. The high pressures associated with the compressed material would also naturally explain why current star formation in this system is mainly concentrated in SSCs. *[Ekta and Jayaram N. Chengalur with S. A. Pustilnik]*



Left-hand panel: The GMRT HI image (contours) of SBS 0335-052E, at an angular resolution of 7x6 arcsec (contours, overlaid on an HST ACS continuum image (grey-scale).The ionized emission filaments from the large superbubble seen in the HST image can be seen to be expanding into the low density part of the HI gas.

Right-hand panel: same as in the left-hand panel, except that the resolution of the HI image is 4x3 arcsec. High density HI gas can be seen to confine the star forming region. From these images the propagating star formation observed to occur in this galaxy can be seen to be a consequence of the ionized superbubble expanding into a medium with a tidally produced density gradient.

We examined the positions of XMD galaxies in the luminousity-metallicity (L-Z) and mass-metallicity (M-Z) planes, with respect to the L-Z and M-Z relations of blue compact galaxies (BCGs) and dwarf irregular (dI) galaxies. We found that while the metallicities of some low-luminosity XMD galaxies are consistent with those expected from the L-Z relation, other XMD galaxies are deviant. We suggested that a galaxy should be regarded as XMD, in a statistically significant manner, only if it lies below the 95 per cent confidence interval around the L-Z relation for BCGs. Of our sample of XMD galaxies, we found that more than half are XMD by this criterion. We also found that the XMD galaxies have lower effective yield than BCG/dI galaxies of similar baryonic mass. Motivated by the fact that interactions are common in XMD galaxies, we suggested that improved (tidally-driven) mixing of the interstellar media (ISM) in XMD galaxies leads to a lowering of both, the measured metallicity and the calculated effective yield. We suggest that XMD galaxies are deviant from the L-Z relation because of a combination of being gas-rich (i.e., having processed less gas into stars) and having more uniform mixing of metals in their ISM. *[B. Ekta & Jayaram N. Chengalur]*

Circumnuclear ring in NGC 2997:

NGC 2997, an SBc type low-inclination galaxy similar to the Milky Way, has been observed in the radio continuum at several GMRT frequencies. We find that the global spectrum is flatter if only the GMRT data at the lower frequencies are considered compared with the higher frequency data. In our highest resolution image at 1280 MHz, we resolve the bright nucleus into a circumnuclear ring of star forming hotspots. The ring has a diameter of 750 pc and coincides with the near- IR and UV ring. The mean star formation rate in the hotposts is about 0.024 solar mass/year. No active nucleus is detected at the centre of the circumnuclear ring. *[Jitendra Kodilkar and N. G. Kantharia, with S. Ananthakrishnan]*

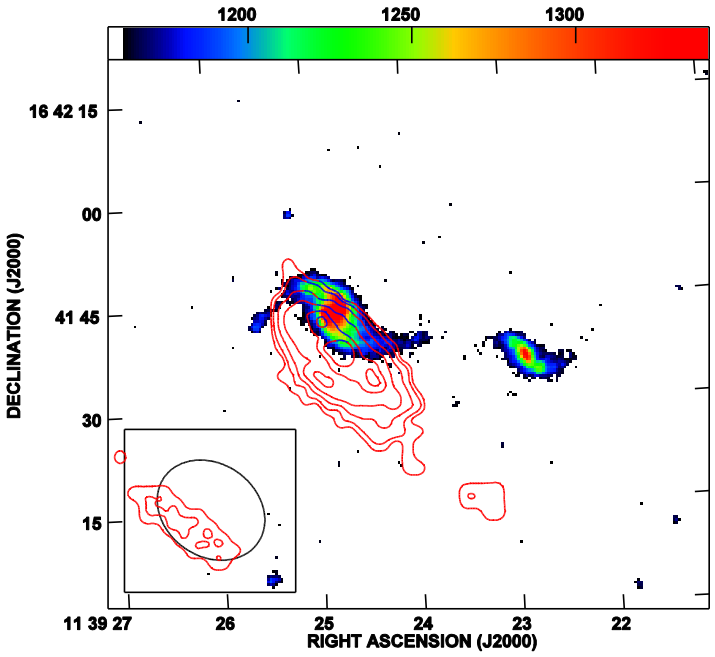
Blue Compact Dwarf Galaxies:

A small sample of five BCD galaxies selected from a larger optical sample were observed with the GMRT in the radio continuum and the 21cm spectral line of the hydrogen atom. Since only a few BCDs have been studied so extensively in the radio region, our results enhance the understanding of these systems. The observed low-frequency radio spectrum of the galaxies range from a simple power law to showing a turnover at the lowest frequencies. A correlation with the environment that these galaxies reside in is noticed, after combining our sample with data from literature. We note that the low frequency radio emission appears to be from a younger electron population and confined to the star forming regions in isolated galaxies and more widespread in galaxies in denser

environments. These results should be confirmed on a larger sample. [*N. G. Kantharia with S. Ramya and T. P. Prabhu]*

A possible pair of interacting galaxies at z = 0.0693:

An intriguing pair of galaxies with striking morphological similarity in the optical SDSS image has been imaged in the HI 21cm line using the GMRT. We have detected hydrogen emission from the larger galaxy at a redshift of 0.0693 with the peak significantly displaced from the optical peak.



SDSS DR6 r-band image of the pair of galaxies J113924.74+164144.0 and J113924.74+164144.0 overlaid with the contours

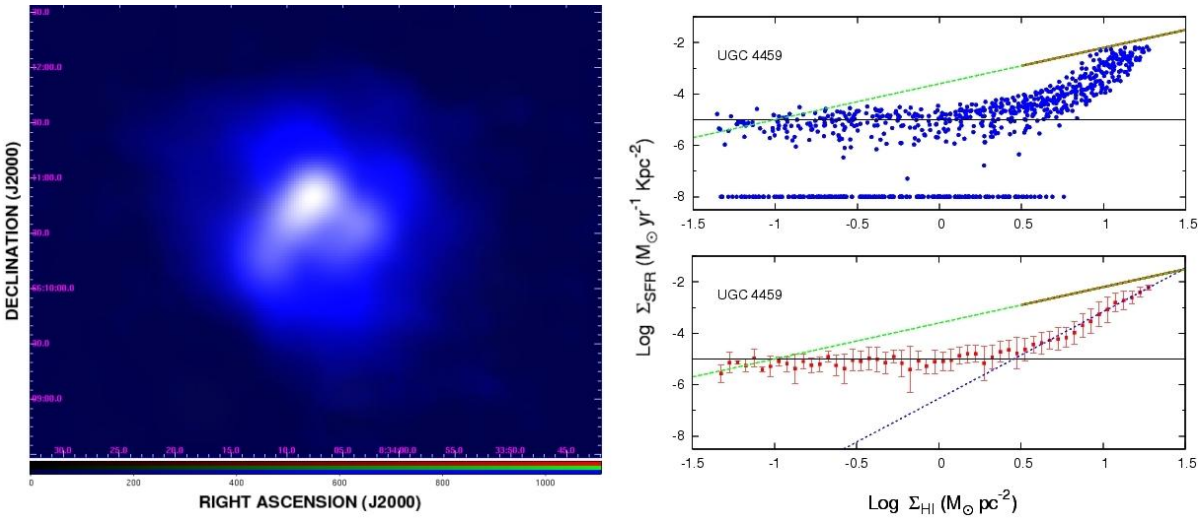
This, we interpret as a signature of tidal interaction. We also detect hydrogen from one of the galaxies in another pair of galaxies separated by about 600 kpc from the first pair. The larger galaxy in this pair shows obvious distortions, also likely to be tidal in origin. We suggest that the two galaxies in each pair are interacting and also cannot rule out the possibility that the two pairs have interacted at an earlier epoch. These results have been submitted to the Letters section of the Monthly Notices of the Royal Astronomical Society. *[N. G. Kantharia and Nirupam Roy with Chandreyee Sengupta]*

The faint irregular galaxy GMRT survey (FIGGS):

The intrinsic axial ratio distribution of the gas discs of extremely faint MB < -14.5 dwarf irregular galaxies observed as part of the Faint Irregular Galaxy GMRT Survey (FIGGS) were determined. Assuming that the discs can be approximated as oblate spheroids, the intrinsic axial ratio distribution can be obtained from the observed apparent axial ratio distribution. A variety of methods were used to do this, and the final results are based on using Lucy's deconvolution algorithm. This method is constrained to produce physically plausible distributions, and also has the added advantage of allowing for observational errors to be accounted for. While one might a priori expect that gas discs would be thin (because collisions between gas clouds would cause them to quickly settle down to a thin disc), it is found that the HI discs of faint

dwarf irregulars are instead quite thick, with mean axial ratio <q> ~ 0.6. While this is substantially larger than the typical value of ~0.2 for the stellar discs of large spiral galaxies, it is consistent with the much larger ratio of velocity dispersion to rotational velocity (sigma/v_c) in dwarf galaxies. These findings have implications for studies of the mass distribution and the Tully-Fisher relation for faint dwarf irregular galaxies, where it is often assumed that the gas is in a thin disc. *[Sambit Rouchowdhury, and Jayaram Chengalu with Ayesha Begum and I. D. Karachentsev]*

The relationship between the gas column density (Sigma_gas) and the star formation rate (SFR) surface density (Sigma_SFR) for a sample of 23 extremely faint dwarf irregular galaxies drawn from the Faint Irregular Galaxy GMRT (Giant Metrewave Radio Telescope) Survey (FIGGS) was studied. The sample galaxies have a median HI mass of 2.8 x 10^7 Msolar and a median blue magnitude MB ~ -13.2. Sigma_SFR is derived from Galaxy Evolution Explorer (GALEX) data, while Sigma_gas is derived from the GMRT-based FIGGS HI 21-cm survey data. We find that Sigma_gas averaged over the star-forming region of the disc lies below most estimates of the `threshold density' for star formation, and that the average Sigma_SFR is also lower than would be expected from the `Kennicutt-Schmidt' law. This deviation is indicative of an environmental dependence of star formation efficiencies, since the Kennicutt relation was derived from data on the central regions of large spiral and starburst galaxies. The star formation efficiency in small galaxies may be more relevant to modelling of star formation in gas-rich, low-metallicity systems in the early universe. The data was also used to look for small-scale (400 and 200pc) correlations between Sigma_SFR and Sigma_gas. For 18 of our 23 galaxies, it is found that



Sigma_SFR can be parametrized as having a power-law dependence on Sigma_gas. The power-law relation holds until one reaches the sensitivity limit of the GALEX data, i.e. no evidence is found for a `threshold density' below which star formation is completely cut off. The power-law slopes and

coefficients however vary substantially from galaxy to galaxy, and are in general steeper than the value of ~1.4 derived for large galaxies by Kennicutt. Further, as for the globally averaged quantities, the Sigma_SFR at 400pc resolution is in general lower than that predicted by the Kennicutt relation, with the deviation decreasing with increasing Sigma_gas. *[Sambit Rouchowdhury and Jayaram Chengalur with Ayesha Begum and I. D. Karachentsev]*

Fine structure in the ISM of harassed galaxies:

Galaxy harassment is an important mechanism for the morphological evolution of galaxies in clusters. The spiral galaxy NGC4254 in the Virgo cluster is believed to be a harassed galaxy. We have analysed the power spectrum of HI emission fluctuations from NGC4254 to investigate whether it carries any imprint of galaxy harassment. The power spectrum, as determined using the 16 central channels which contain most of the HI emission, is found to be well fitted by a power law $P(U) = AU^{\alpha}$ with $\alpha = -1.7 +/- 0.2$ at length-scales 1.7 to 8.4kpc. This is similar to other normal spiral galaxies which have a slope of ~ -1.5 and is interpreted as arising from two-dimensional turbulence at length-scales larger than the galaxy's scale height. NGC4254 is hence yet another example of a spiral galaxy that exhibits scale-invariant density fluctuations out to length-scales comparable to the diameter of the HI disc. While a large variety of possible energy sources like protostellar winds, supernovae, shocks, etc. have been proposed to produce turbulence, it is still to be seen whether these are effective on length-scales comparable to that of the entire HI disc. On separately analysing the HI power spectrum in different parts of NGC4254, it is found that the outer parts have a different slope (alpha = –2.0 +/–0.3) compared to the central part of the galaxy (alpha = –1.5 +/- 0.2). Such a change in slope is not seen in other, undisturbed galaxies. It is suggested that, in addition to changing the overall morphology, galaxy harassment also affects the fine scale structure of the interstellar medium, causing the power spectrum to have a steeper slope in the outer parts. *[Jayaram N. Chengalur with Prasun Dutta, Ayesha Begum and Somnath Bharadwaj,]*

Near-infrared properties of lenticular galaxies:

We have studied the luminosity and environmental dependence of structural parameters of lenticular galaxies in the near-infrared K band. Using a 2D galaxy image decomposition technique, we extracted bulge and disc structural parameters for a sample of 36 lenticular galaxies observed by us. By combining data from the literature for field and cluster lenticulars with our data, we studied correlations between parameters that characterize the bulge and the disc as a function of luminosity and environment. We found that scaling relations such as the Kormendy relation, photometric plane and other correlations involving bulge and disc parameters show a luminosity dependence. This dependence can be explained in terms of galaxy formation models in which faint lenticulars ($M_K > —24.5$) formed via secular formation processes

that likely formed the pseudo-bulges of late-type disc galaxies, while brighter lenticulars (M_K <—24.5) formed through a different formation mechanism most likely involving major mergers. Our results support the idea that the bulge and disc components fade after the galaxy falls into a cluster, while simultaneously undergoing a transformation from spiral to lenticular morphologies.*[Yogesh Wadadekar with S. Barway and A. Kembhavi]*

COSMOLOGY

Evolution of the gas content of galaxies:

Observations from the Giant Metrewave Radio Telescope were used to measure the atomic hydrogen gas content of 324 galaxies around the galaxy cluster Abell 370 at a redshift of z = 0.37 (a look-back time of ~4 billion years). The HI21cm emission from these galaxies was measured by co-adding their signals using precise optical redshifts obtained with the Anglo-Australian Telescope. The average HI mass measured for all 324 galaxies is (6.6 +/- 3.5) 10^9 Msolar, while the average HI mass measured for the 105 optically blue galaxies is (19.0 +/- 6.5) 10^9 Msolar. The significant quantities of gas found around Abell 370 suggest that there has been substantial evolution in the gas content of galaxy clusters since redshift z = 0.37. The total amount of atomic hydrogen gas found around Abell 370 is up to approximately eight times more than that seen around the Coma cluster, a nearby galaxy cluster of similar size. Despite this higher gas content, Abell 370 shows the same trend as nearby clusters that galaxies close to the cluster core have lower HI gas content than galaxies further away where the galaxy density is lower. The optically blue galaxies contain the majority of the HI gas surrounding the cluster. However, there is evidence that the optically red galaxies contain appreciable quantities of HI gas within their central regions. The Abell 370 galaxies have HI mass-to-optical-light ratios similar to local galaxy samples and have the same correlation between their star formation rate and HI mass as found in the nearby galaxies. The average star formation rate derived from [OII] emission and from deredshifted 1.4 GHz radio continuum for the Abell 370 galaxies also follows the correlation found in the local Universe. The large amounts of HI gas found around the cluster can easily be consumed entirely by the observed star formation rate in the galaxies over ~4 billion years (from z = 0.37) to the present day. Abell 370 appears set to evolve into a gas-poor system similar to galaxy clusters observed in the local Universe. *[Jayaram N. Chengalur with Philip Lah, M. Pracy, F. H. Briggs, M. Colless, et al.]*

A new technique to image high-redshift damped Lyman-alpha systems:

A methodology was set up for a new imaging program aimed at identifying and characterizing the host galaxies of damped Lyman-α absorbers (DLAs) at z ≥2. This involves targeting quasar sightlines with

multiple DLAs, using the higher-redshift absorber as a "blocking filter" (via its Lyman-limit absorption) to eliminate all far-ultraviolet (FUV) emission from the quasar. This allows direct imaging of the rest-frame FUV continuum emission of the lower-redshift DLA, shortward of the Lyman limit of the higher-redshift absorber, without any quasar contamination. This is an updated form of a dropout technique previously applied to image high-z MgII absorbers. Spectroscopic follow-up of candidate hosts will provide the first statistically-large sample of the host galaxies of high-redshift DLAs. A new formalism was also set up, based on galaxy number counts and Bayesian statistics that allows the identification of a bona fide sample of DLAs that are too faint to be directly confirmed by such follow-up spectroscopic studies. The new imaging technique and Bayesian formalism was applied to two QSO sightlines, with target DLAs at z ~2.686 towards J0731+2854 and at z ~ 2.919 towards J2114-0055, finding a number of candidate host galaxies in each field. For the z ~ 2.686 DLA towards J0731+2854, one of the candidates has a low impact parameter, b = 1.54" = 11.89 kpc, and is identified as the likely host by the Bayesian procedure; this object has an inferred star formation rate of (4.22 ± 0.32) h_{72}^{-2} $M_\odot$ yr^{-1}. In the case of the z ~ 2.919 DLA towards J2114-0055, none of the candidate host galaxies lie within ~20 kpc of the QSO sightline, and the Bayesian procedure finds no likely host amongst the candidates; the 3σ limit on the star formation rate of the DLA galaxy is 1.7 h_{72}^{-2} $M_\odot$ yr^{-1}. *[Nissim Kanekar with Michele Fumagalli, Jason X. Prochaska and John O'Meara]*

Rest-Frame UV Versus Optical Morphologies of Galaxies: *The Importance of Morphological K-Correction:*

We compared the rest-frame UV morphologies of a sample of 162 intermediate- redshift (*z* (median) = l.02) galaxies with their rest-frame optical morphologies. Our sample was chosen from the deepest near-UV image obtained with the Hubble Space Telescope (HST) using the Wide Field Planetary Camera 2 (WFPC2; F300W) as part of the parallel observations of the Hubble Ultra Deep Field campaign overlapping with the HST / ACS Great Observatories Origins Deep Survey data set. We performed single-component Sérsic fits in both WFPC2/F300W (rest-frame UV) and ACS/F850LP (rest-frame optical) bands and deduced that the Sérsic index *n* is estimated to be smaller in the rest-frame UV compared to the rest-frame optical, leading to an overestimation of the number of merger candidates by ~40% -100% compared to the rest-frame optical. We found that most objects in our sample are probably clumpy star-forming galaxies or minor mergers, both of which are essentially contaminants, if one is interested in identifying major mergers. In addition, we also found evidence that the axis ratio *b/a* is lower, in rest-frame UV compared to the rest-frame optical. We also found that in the rest-frame UV, the number of high ellipticity ($e \geq 0.8$) objects are higher by a factor of ~2.8 compared to the rest-frame optical.

This indicates that the reported dominance of elongated morphologies among high-z Lyman Break Galaxies might just be a bias related to the use of rest-frame UV data sets in high-z studies. *[Yogesh Wadadekar with A. Rawat and D. de Mello]*

Quantitative measure of evolution of bright cluster galaxies at moderate redshifts:

Archival data from the Hubble Space Telescope were used to study the quantitative morphological evolution of spectroscopically confirmed bright galaxies in the core regions of nine clusters ranging in redshift from $z = 0.31$ to 0.84. Morphological parameters derived from two-dimensional bulge-disc decomposition were used to quantify the evolution. A sophisticated software pipeline was developed to automate the processing. We found an increase in the mean bulge-to-total luminosity ratio as the Universe evolves. We also found a corresponding increase in the fraction of early-type galaxies and in the mean Sérsic index. These results have implications to physical mechanisms for evolution of galaxy morphology. *[Yogesh Wadadekar with V. Vikrarm and A. Kembhavi]*

ACTIVE GALAXIES

X-shaped (Winged) radio sources:

X-shaped radio morphology is now known to be exhibited by a significant fraction of intermediate power radio galaxies. The steep surge in interest in these XRGs stems from their being potential sources of gravity waves emitted during merger of two supermassive black holes, leading to *spin-flip*. To probe this class of sources (XRGs) a critical review of their existing models was prepared and a new mechanism was proposed which can explain their unusual properties and also some peculiar aspects of radio galaxies, in general. Motivated by the multi-band observations of the nearest radio galaxy Centaurus A, this model emphasizes the role of interactions between the jets and the shells of gas and stars, formed in the aftermath of merger of a radio-loud elliptical with a gas-rich disk galaxy. *[Gopal Krishna with P.L. Biermann, L. A. Gergely, P. J. Wiita]*

AGN and cosmic-rays:

The aforementioned interaction of the Cen A jet with gaseous shell in the middle radio lobe region has been argued to be capable of explaining the ultra-high energy cosmic ray (UHECRs) events detected with Auger and HiRes arrays above 6.10^{19} eV. In a model developed for this scenario it was argued that the relativistic jet accelerates lower energy heavy seed cosmic rays to UHECRs during the time scale it takes to traverse the shell. A specific prediction of this model is that, in contrast to Fe nuclei, protons and

lighter nuclei would show greater anisotropy and thus be preferentially seen to arrive from the direction of Cen A. *[Gopal Krishna with P. L. Biermann, V. de Souza, P. J. Wiita]*.

AGN variability:

Radio Intermediate Quasars (RIQs) are a rare and very sparsely studied subclass of quasars, although they are believed to provide an important link between radio-quiet and radio-loud quasars. According to a widely held view RIQs are the compact relativistic jets of radio-quiet quasars, that happen to be beamed in our direction. A similar geometrical relationship is believed to connect radio-loud quasars and blazars. However, from a first systematic study of intra-night optical variability (INOV) of RIQs, it was demonstrated that in comparison to blazars, RIQs show negligible INOV. This unexpected result, puts a question mark on the currently most popular interpretation of RIQ phenomenon. [Gopal Krishna with A. Goyal, S. Joshi, Ram Sagar, G. C. Anupama, D.K. Sahu and P.J. Wiita].

AGN variability:

During a long-term program of intranight optical monitoring of Active Galactic Nuclei, a unique case was discovered whereby a classical BL Lac object (PKS 0735+178) has not shown large intra-night optical variability (INOV) on any of the 17 nights it was monitored over the past 11 years (for such radio selected BL Lacs, large INOV with amplitude > 3% is known to occur on a given night with 50% probability!). Another unique finding based on its 2cm VLBI performed at 23 epochs between 1995 and 2009, is that the sharply kinky jet of this BL Lac was found to become linear at the time of a large optical flare. Thus, the compact radio jet exhibits a direct response to nuclear flaring. Also, interestingly, no new VLBI components were found to be ejected from the nucleus of this BL Lac during the past 15 years of its VLBI monitoring; extremely unusual for a BL Lac. *[Gopal Krishan with A. Goyal, Ram Sagar, G. C. Anupama, D.K. Sahu, S. Britzen, M. Karouzos, A. Zensus , B.P. Gong, J.W. Zhang, M.F. Aller and H.D. Aller].*

Radio and x-ray study of 3C457:

Multifrequency radio observations with the GMRT and Very Large Array (VLA), and X-ray observations with the X-ray Multi-Mirror Mission (XMM-Newton) telescope of the giant radio source (GRS) 3C457 have been reported. The core, lobes and the environment of the GRS have been detected in X-rays. The relationships between the radio and X-ray emission have been determined, and the X-ray emission from the lobes has been attributed to inverse Compton scattering of cosmic microwave background photons.

The magnetic field strength of the lobes is very close to the equipartition value. Both the lobes are in pressure balance near the hotspots and apparently under pressured towards the core. The X-ray spectrum of the core of the GRS consists of an unabsorbed soft power-law component and a heavily absorbed hard power-law component. The soft unabsorbed component is likely to be related to the radio jets. *[D.J. Saikia with C.Konar, M.J. Hardcastle and J.H. Croston]*

Spectral ages of giant radio sources:

Low-frequency observations starting from ~150 MHz with the GMRT, and high-frequency observations with the VLA of two large radio galaxies 3C46 and 3C452 have been presented. These observations were made with the objectives of estimating their spectral ages and examining any evidence of diffuse extended emission at low radio frequencies due to an earlier cycle of activity. While no evidence of extended emission due to an earlier cycle of activity has been found, the spectral ages have been estimated to be ~ 15 and 27 Myr for the oldest relativistic plasma seen in the regions close to ~ the cores for 3C46 and 3C452, respectively. The spectra in the vicinity of the hotspots are consistent with a straight spectrum with injection spectral indices of ~1.0 and 0.78, respectively, somewhat steeper than theoretical expectations *[S. Pal and D.J. Saikia with S. Nandi, A. Pirya, C. Konar and M. Singh]*

High rotation measures in compact sources:

VLBA polarimetric observations of the CSS sources 3C119, 3C318, and 3C343 at 5 and 8.4 GHz have been reported. The CSS source 3C119 has source rest-frame RM values up to ~10200 rad/m^2 in a region which coincides with a change in the direction of the inner jet, and is located ~325 pc from the core. In 3C318, a rest-frame RM of ~3030 rad/m^2 has been estimated for the brightest component. The CSS source 3C343 exhibits complex field directions near the emission peaks, which indicate rest-frame RM values in excess of ~6000 rad/m^2. The available data on mas-scale rest-frame RM estimates for CSS sources show that these have a wide range of values extending up to ~40000 rad/m^2 , and could be located at projected distances from the core of up to ~1600 pc. In addition to an overall density gradient of the magneto-ionic medium, geometry, orientation and modes of fuelling, the high values of RM in CSS sources are possibly due to dense clouds of gas interacting with the radio jets *[D.J. Saikia with F. Mantovani, A. Rossetti, W. Junor and C.J. Salter]*.

A double-double radio quasar:

Striking examples of episodic activity in active galactic nuclei are the double-double radio galaxies (DDRGs) with two pairs of oppositely directed radio lobes from two different cycles of activity. Although there are over about a dozen good examples of DDRGs, so far no case of one associated with a

quasar has been reported. GMRT observations of a candidate double-double radio quasar, J0935+0204 (4C02.27) have been reported, in which the radio jets source may also have been intrinsically asymmetric, contributing to the large observed asymmetries in the flux density and location of both pairs of radio lobes *[D.J. Saikia with M. Jamrozy and C. Konar]*.

Episodic activity in AGN:

The radio continuum as well as molecular and atomic gas properties of radio sources which exhibit recurrent or episodic activity have been reviewed, and a few cases of quasars which require further observations to confirm their episodic nature have been presented. The evidence of episodic AGN activity in radio sources in clusters of galaxies has also been highlighted in this review *[D.J. Saikia with M. Jamrozy]*.

Wide-angle tailed radio sources:

Radio images of a sample of six Wide-Angle Tail (WAT) radio sources identified in the ATLAS 1.4,GHz radio survey, and new spectroscopic redshifts for four of these sources have been presented. These WATs are in the redshift range of 0.1469-0.3762, and there is evidence of galaxy overdensities in the vicinity of four of the WATs from either spectroscopic or photometric redshifts. Follow-up spectroscopic observations of the area surrounding the largest WAT, S1189, which is at a redshift of ~0.22 have been presented. The spectroscopic observations, taken using the AAOmega spectrograph on the AAT, show an overdensity of galaxies at this redshift. The galaxies are spread over an unusually large area of ~12 Mpc with a velocity spread of $\sim$4500 km s^{-1}. This large-scale structure includes a highly asymmetric FRI radio galaxy and also appears to host a radio relic. It may represent an unrelaxed system with different sub-structures interacting or merging with one another. Implications of these observations for future large-scale radio surveys have been discussed *[D.J. Saikia with M. Mao, R. Sharp, R.P. Norris, M. Johnston-Hollitt, E. Middelberg and J.E.J. Lovell]*

Search For Ultra Steep Spectrum Radio Sources with GMRT:

We have started a major programme to search for ultra-steep spectrum radio sources, which are candidate high-redshift radio galaxies, with GMRT. This programme is expected to detect sources 50 to 100 times fainter than the known high-redshift radio sources. We have observed several well-known fields to this affect. Preliminary results on a couple of fields yielded several radio sources with spectra steeper than 1.3. A majority of them are compact and unresolved and also not detected in SDSS, which make them good candidates for high-redshift radio sources. *(C. H. Ishwara Chandra, Sandeep Sirothia, S. Pal and Yogesh Wadadekar).*

NEUTRAL HYDROGEN

HI absorption towards 4C29.30:

HI absorption towards the central region of the rejuvenated radio galaxy 4C29.30 (J0840+2949) has been reported with the GMRT. The radio source has diffuse, extended emission with an angular size of ~520 arcsec (639 kpc) within which a compact edge-brightened double-lobed source with a size of 29 arcsec (36 kpc) is embedded. The absorption profile which is seen towards the central component of the inner double is well resolved and consists of six components; all but one of which appears to be redshifted relative to the optical systemic velocity. The neutral hydrogen column density is estimated to be N(HI) = 4.7×10^{21} (Ts/100)(fc/1.0)cm^{-2}, where Ts and fc are the spin temperature and covering factor of the background source, respectively. This detection reinforces a strong correlation between the occurrence of HI absorption and rejuvenation of radio activity suggested earlier, with the possibility that the redshifted gas is fuelling the recent activity *[Yogesh Chandola and D.J. Saikia with Neeraj Gupta]*.

HI absorption towards CTA21:

The discovery of HI 21-cm absorption toward the well-studied Gigahertz peaked spectrum source CTA 21 (4C 16.09) using the Arecibo telescope has been reported. Recently, the frequency band between 700 and 800 MHz was temporarily opened up to radio astronomy when US TV stations were mandated to switch from analog to digital transmissions, with new frequency allocations. CTA 21 has a complex radio structure on a range of scales. The innermost prominent components are separated by ~12 mas while weak diffuse emission extends for up to ~300 mass. The HI absorption profile has two main components, one narrow and the other wider and blueshifted. The total HI column density is $7.9 \times 10^{20} cm^{-2}$, assuming a covering factor of unity and a spin temperature of 100 K. The possibility that CTA 21 may be exhibiting multiple cycles of nuclear activity has been discussed. This new detection in CTA 21 is consistent with a strong trend for detection of HI absorption in radio galaxies with evidence of episodic nuclear/jet activity *[D.J. Saikia and Yogesh Chandola with C.J. Salter, R. Minchin and T. Ghosh]*.

GMRT mini-survey to search for 21-cm absorption in Quasar-Galaxy Pairs at z~0.1:

We have recently completed a 21-cm absorption mini survey of a sample of 5 quasar-galaxy pairs (QGPs), with the redshift of the galaxies in the range $0.03 < z_g < 0.18$ with the GMRT. 21-cm absorption was detected only in one case, with the impact parameter *b,* piercing through the stellar disk of a galaxy having near solar metallicity (i.e $(O/H) + 12 = 8.7$) and star formation rate uncorrected for dust attenuation, of $0.1 M_\odot\ yr$. In the remaining cases, our GMRT spectra provide only an

upper limit on N(HI) in the range, (10^{17} - 10^{18} X T_s cm^{-2}. Combining our sample with the $z < 0.1$ data available in the literature, we find the detectability of 21-cm absorption with integrated optical depth greater than 0.1 km s^{-1} to be 50% for impact parameter b ≤ 20 kpc. Using the surface brightness profiles and well established relationship between the optical size and extent of the HI disk known for nearby galaxies, we conclude that in most of the cases of 21-cm absorption non-detection, the sight lines may not be passing through the HI gas (1σ column density of few times 10^{19} cm^{-2}). A systematic survey of QGPs over a wider redshift range using a large sample is needed to confirm these findings and further understand the nature of 21-cm absorbers.*[Yogesh Wadadekar with N. Gupta, R. Srianand, D. Bowen and D. York]*

SURVEYS

The Seventh Data relese of the Sloan Digital Sky Survey:

The Seventh Data Release of the Sloan Digital Sky Survey A technical paper describing the Seventh Data Release of the Sloan Digital Sky Survey (SDSS), marking the completion of the original goals of the SDSS and the end of the phase known as SDSS-II was published in June 2009. It includes 11,663 deg^2 of imaging data. The catalog contains five-band photometry for 357 million distinct objects. The survey also includes repeat photometry on a 120 degree long, 2.5 degree wide stripe along the celestial equator in the Southern Galactic Cap, with some regions covered by as many as 90 individual imaging runs. We include a co-addition of the best of these data, going roughly 2 mag fainter than the main survey over 250 deg^2. The survey has completed spectroscopy over 9380 deg^2. There are over 1.6 million spectra in total, including 930,000 galaxies, 120,000 quasars, and 460,000 stars. *[Yogesh Wadadekar with members of the large SDSS collaboration]*

SCIENTIFIC INFORMATION AND RESOURCE CENTRE

During 2009-2010, more than 500 books were added in the collection of NCRA and GMRT SIRC. The SIRC web site is now maintained using Drupal Software which is an Open Source Content Management Software.

NPTEL Engineering video talks are procured for the SIRC users during the financial year. Around 2000 videos are available from the series and these talks are available online on Intranet from http://ncra.tifr.res.in/local/Intranet/annualindex.html

Scanning of Prof. D. D. Kosambi archives was completed during the year. The collection includes hand written notes, old articles and different correspondence letters. The total number of pages which are scanned and available in the collection are around 3000.

SIRC has also made available all theses from NCRA in digital format. These are now available online from DSpace repository(http://ncralib1.ncra.tifr.res.in:8080/jspui).

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(Khodad-Administration): Deshmukh N. S., Gadekar S. A., Ganeshan G., Joglekar A.C., Kanade D S, Kharmale V.S., Naik R. Y., Pokharkar D. B., Shinde S. B., Solanki J. K.

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(Khodad-Scientific/Technical): Ajith Kumar B., Amit Kumar, Arun Kumar H., Bachal Shailendra J, Bagde S. K., Balasubramaniam R., Bhalerao V. B., Bhat Sandesh R., Bhonde I. S., Bhong D.B., Bhumkar Abhay K., Buch Kaushal D., Burle S. M., Chaudhari S C, Dongare S.N., Dubal Shilpa S., Gaikwad K. R., Gaikwad P. S., Gaikwad S. R., Gaikwad Yogesh, Ganla Atul A., Ghangale H. K., Ghangale J. L., Ghorpade D.D., Gnanaraj Shelton J., Gopinathan M., Gupta Sweta, Halagali Irappa, Hande P. J., Haokip T. S., Jangade Digambar A., Joardar S., Kale H. S., Kamble J. R., Kamble U. S., Kanade C. P., Kasar P. N., Katore S. N., Kedari H.V., Khande Deepak R., Kodilkar J. P., Kotwal A. R., Kudale S. S., Lokhande S. K., Mirajkar S.S., Misal Mahadev B., Muley Mekhla, Nalawade J. R., Nanaware D. K., Navale R. S., Nayak Sambhunath, Parate M. D., Patil B. S., Patil Manish S., Patil S. D., Patil T. M., Phakatkar S. V., Poonattu A. M., Praveen Kumar A., Raja K., Rajendran B., Ramesh S., Rao Hanumanth B, Raskar N.S., Raut A. N., Raybole P. A., S. Harshavardhan Reddy, Sabhapathy Suresh, Sakthivel A., Samble Manisha S., Sandikar Aarti, Sankarasubramanian G., Satheesh C., Sherkar S S, Shigwan R. B., Shinde N. D., Shinde N.J, Sisodiya Nareshkumar, Somwanshi M. D., Suresh Kumar S., Sutar Ganesh N., Swami R. V., Temgire D. D., Temkar Vishal B., Thakur Abhijit R.., Thiyagarajan B., Thorat G. G., Thorat K. T., Umbarje M. S., Uprade Raju, Vasave Rupsing J., Vishwakarma Ajay M., Walunj D. V.

(Khodad-Trainee): Ranka Trupti, Srinivasa Rao B., Suryawanshi P M., Sutar Mayur Mohan

(Ooty-Academic) : Agalya. G, Manoharan P. K., Shaikh Shaheda Begum

(**Ooty-Administration):** Lali Shantha Kumari N, Packiaraj V., Selvaraj G. J.

(Ooty-Auxiliary): Aravindakrishnan K. G., Chandrasekaran R., Chandrasekharan M., Chandrasekharan V., D. Nandagopal, Gangadharan K., Ingale A.S., Jayaraman P. K., Kalyansundaram K., Karpagam M, Kumaresan N., Mahendran R., Moorthy T. K., Rajakumar R., Rajamohan S., Ravi B. K., Ravikumar D., Rodrigues I. E., Salathnathan D., Sankaran M., Senthil Kumar S.J., Siva J., Subramani P., Thangakumar A, Vasu R., Venkatasubramani R., Venkatesha C. M.

(Ooty-Trainee): Franklin Joseph R., Magesh V., Nevile Jude R., Praveen P., S. Dhivya

A software back-end for the GMRT :

The final version of the 32 antenna, 32 MHz GSB (GMRT software back-end) was released for regular GTAC observations at the GMRT. The GSB implements a fully real-time back-end for the current requirements for the GMRT, and includes a full correlator and pulsar receiver with a incoherent and phased array beamformer. Work for connecting the GSB to the 32 MHz wide baseband signals using the new IF to BB converters was completed. A user-friendly GUI for configuration and control of the GSB was also completed. Initial results show very good performance of the GSB, including high dynamic range images. Work on adding new, enhanced modes of operation such as flexible time-frequency resolution, full polarimetry mode for 32 MHz bandwidth, a gated interferomety mode, coherent dedispersion of phased array voltage data, and basic RFI excision algorithms was also initiated. The GSB also supports a baseband recording mode with offline playback and analysis capabilities, wherein raw voltage signals from all the antennas can be recorded on a 64 TB array of disks, for durations upto 12 hours. Initial tests of this mode of the GSB were carried out, and a basic version was made operational. *[J. Roy, Y. Gupta, B. Ajithkumar, J. P. Kodilkar, S. Kudale, S. N. Katore, N. S. Raskar with Ue-Li Pen and Jeff Peterson]*

A first light image from the GSB : radio intensity map of the region of the sky around the source 1609+266, at 1280 MHz. Beside the central point source J1609+266 of 4.8 Jy, a few other sources, including a couple of double radio sources can be clearly seen. The dynamic range achieved in this image is 1.4 x 10^5. (Courtesy : Subhashis Roy)

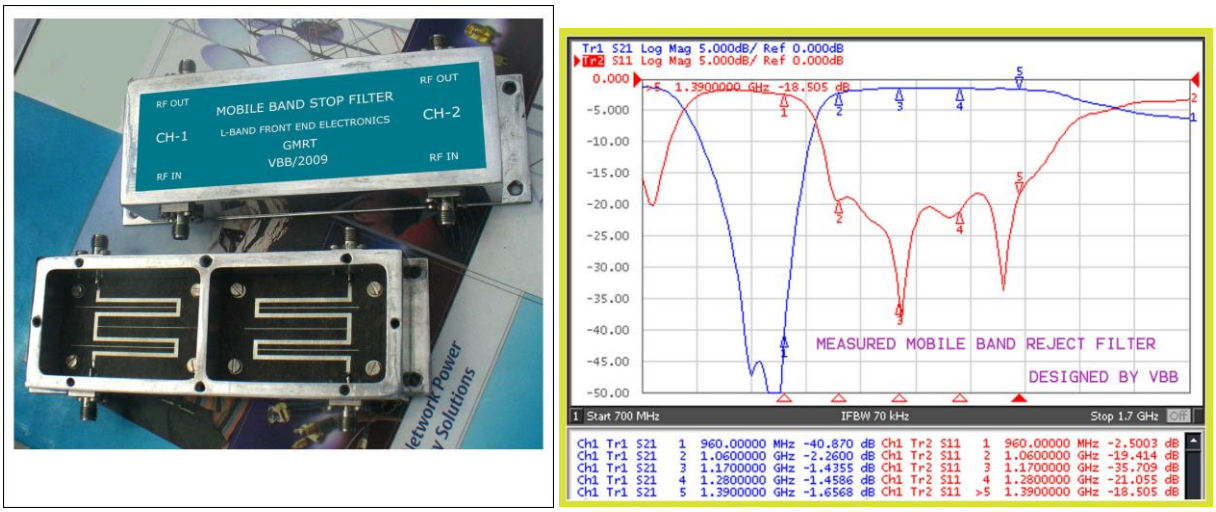
Transient Analysis Pipeline for the GMRT :

The dynamic radio sky has tremendous untapped potential for exciting and innovative science. With its low frequencies, high sensitivity and interferometric capabilities, the GMRT is in a unique position to make a significant impact in this field. With this in mind, a program has been initiated to develop a pipeline for real-time detection and recording of transient events, that will eventually run in piggy-back fashion with any regular GMRT observation. This pipeline capitalises on the GMRT's interferometric and sub-array capabilities and exploits the versatility offered by the newly released GMRT Software Backend (GSB). A software-based transient finding system is being developed, which will process in real-time

multiple incoherent array data streams from the GSB, for transient candidates, and trigger the data capture system which will then record relevant raw data segments for detailed offline processing. This pipeline uses dispersion search and filters out spurious events based on co-incidence analysis amongst the four incoherent beams. The final version will be optimized to run on a CPU-GPU combination. A pilot project that tests out the ideas and various ingredients required in the development of this pipeline, has been initiated at the GMRT. *[Jayanta Roy, Jayanti Prasad, Jayaram Chengalur, Yashwant Gupta, with Ramesh Bhat, Matthew Bailes, Willem van Straten and Steven Tingay]*

RF Front-End Systems:

Design of new front-end receiver systems for the GMRT upgrade : The final design for the upgraded L-Band (1000-1500 MHz) Receiver for GMRT has been completed, tested and installed on 12 antennas of GMRT. This improved receiver has high dynamic range amplifiers incorporated for better immunity against higher levels of radio frequency interference (RFI) generated by the cellular mobile telephone systems. In addition, band-reject filters have been placed after the low noise amplifier to suppress the RFI



Cellular Mobile Band-Stop Filter

from GSM 900 and CDMA cellular mobile RF carriers by about 45 dB. The upgraded receiver has 32 dB higher ccmpression dynamic range (CDR) and 34 dB improvement in the output third-order intercept point (OIP3). *[Vilas B. Bhalerao & A. Praveen Kumar]*

A final version 100-500 MHz LNA for use with the 150 MHz band of GMRT has been designed, tests completed and mass production started. This was designed using Avago Tecnologies' pHEMT ATF-54143 in a drain to source feedback configuration resulting in flat gain of about 33 dB, flat noise temperature of about 60 degrees Kelvin and very good stability. *[Vilas B. Bhalerao]*

A new P-Band Front-End has been designed with an enhanced bandwidth of 100 MHz, covering 300 to 400 MHz. A prototype has been fabricated and tested fully. The design uses Hittite Microwave Corporation make GaAs MEMT MMIC LNA and gives a noise temperature of 55 degree Kelvin over the band. This unit will be integrated with the existing 327 MHz feed and tested on a GMRT antenna. *[Aarti Sandhikar & Manisha Parate]*

A first prototype of the 200-500 MHz LNA using Avago Technologies make pHEMT ATF-54143 has been designed and fabricated. Optimisation is under progress for a target noise temperature of about 30 degree Kelvin, gain of about 33 dB, and a VSWR of less than 2:1. *[Anil N. Raut]*

Design of new feeds for the GMRT upgrade : In order to provide a wide-band feed for the GMRT to cover low frequencies (200 to 500 MHz), several design choices have been looked at in detail :

A dipole feed with a conical reflector has been designed to cover the frequency range of 200-550 MHz. Simulation results using the 3D EM simulation software WIPL-D shows excellent radiation pattern symmetry in the E- and H- planes, with about -12 dB taper for 200 to 550 MHz. Design optimisation is under progress for improved VSWR at certain frequencies. *[A. Praveen Kumar & B. Hanumanthrao]*

A standard cavity-backed dipole feed for 250-450 MHz was designed, fabricated and tested. Design optimisation is under progress. In another exercise, the existing 327 MHz Kildal feed which consists of dipole, plane reflector & beamforming ring was modified by changing the sleeve to increase the bandwidth by 55 MHz at the higher frequency end and a prototype was tested. *[G. Sankarasubramanian & B. Hanumanthrao]*

Fiber Optics:

RF over Fiber using Coarse Wavelength Division Multiplexing (CWDM) Technique: As part of the GMRT upgrade activities, a CWDM based broadband analog fiber optic link has been designed and implemented. The system uses 4 channels operating at 1510 nm, 1530 nm, 1550nm and 1570 nm wavelengths. Two channels are used to bring the full RF band (from DC to 2 GHz) for two polarisations, directly from the frontend system without any frequency translation, to the central processing station for further signal processing. A third channel is used to support the existing GMRT return fiber link from the antenna, thereby allowing for the coexistence of the old and new systems. This newly developed CWDM system has better dynamic range compared to DWDM system developed earlier by our group. At present, 4 antennas with DWDM system and 2 antennas with CWDM system are working, and their performance is being evaluated before taking a final decision for mass production. *[S.Sureshkumar, A. Pravin Raybole, Satish Lokhande, M. Gopinathan]*

GBE fiber optic link for antenna control application: A 100 Mbps Ethernet links from the central station to antennas have been installed for 3 GMRT antennas, for antenna control and monitor applications. They are now getting updated with 1 GBE fiber optic link for better bandwidth. *[S. Sureshkumar, A. Pravin Raybole]*

Fiber optic LAN for GMRT - RFI mitigation: As a part of RFI mitigation and modernisation efforts at the GMRT, a fiber optic LAN network is in the final stages of implementation and testing at the central observatory building. This network has more than 100 user locations, connecting all the laboratories and offices in the building, with 50% spare capability for future expansion. It uses OM3 multimode fiber for better bandwdith distance product, and connectorized fiber optic cables with pulling eye technique for fast installation and reliable connectivity. Its use will help reduce radio frequency interference from copper cables, switches and hubs placed in unshielded area of the GMRT building. *[S. Sureshkumar, A. Pravin Raybole, Satish Lokhande]*

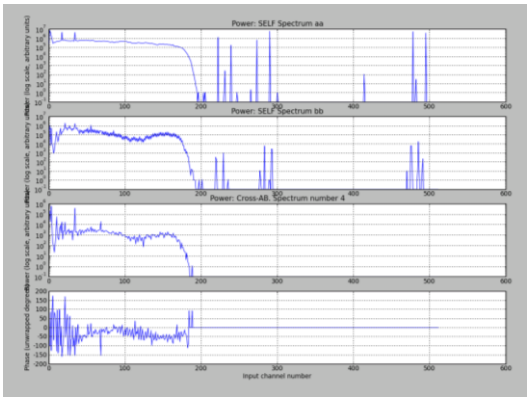
Backend Systems for the GMRT upgrade

As part of the GMRT upgrade, a new backend system is being designed in order to receive, digitize and process the analog signals of 400 MHz bandwidth from 30 antennas to produce interferometry and array outputs. For this, we are using the CASPER (Centre for Astronomy Signal Processing and Research) based design approach for implementation of the digital backends. We also plan to add facilities for RFI cancellation (in both analog & digital domain) and raw data recording and software based backends. The back-end has an analog pre-processing section, followed by the main digital processing section.

Analog Backend System **:** The analog backend section will carry out signal conditioning of the wideband signals coming from the optical fibre receivers in the central building. The design and circuit analysis of this section has been completed, and the first prototype is being assembled. The new circuits provides a 400 MHz bandwidth with improved dynamic range. Facility for gain calibration and monitoring of the system parameters on a continuous basis is included. The necessary local oscillator circuits have also been finalised and prototype is ready for lab tests. [*B. Ajithkumar, Sweta Gupta, Navnath Shinde, D.K. Nanaware, Atul Ganla, Sudhir Phakatkar and P.J. Hande*]

Digital Backend System **:** The digital part of the back-end system digitizes the data and implements the correlator and beam former for the interferometry and array mode outputs, respectively. As part of the development process, single board correlator circuits with two and four antenna inputs have been designed, implemented and tested with lab sources as well as with actual antenna signals.

The CASPER based single board correlator in the lab test set-up



First results from the FPGA based 300 MHz bandwidth correlator showing signals from GMRT antennas C04 and C11. Top two panels show the self-correlation for 110 MHz signal at L-band, while the bottom panel shows cross-correlation amplitude and phase after proper delay correction on an astronomical calibrator source.

Further, a modular design for a FPGA based correlator which can be expanded to add extra antenna signals (called packetised correlator) is being developed in the lab. In the process, we have also developed new blocks for digital delay correction and fringe correction that have been added to the CASPER library. [*Sandeep Choudhari, G.J. Shelton, Mekhala Muley, B. Ajithkumar and Yashwant Gupta*]

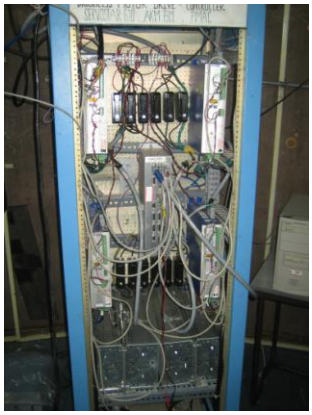
We are also working on a hybrid design scheme where the digitized data, after some pre-processing on the FPGA boards, is sent to a network of computers using 10 GigE links for further processing of the signals in software. Initial steps have been completed, where we are able to capture the data and do simple operations in software and display the resulting spectra. [*Harshvardhan Reddy, Sanjay Kudale, G.J. Shelton and Yashwant Gupta*]

A digital noise source is being developed using Linear Feedback Shift Registers – this will be useful in lab tests of the correlator designs and will be added as a new block in the CASPER library. A voltage time domain clipper algorithm is also being developed for the FPGA based correlator. [*Kaushal Buch*]

GMRT Servo system upgrades:

As part of the upgrade of GMRT servo system, extensive tests for validation of new Brush-less DC motors and drives (Figure 3) were carried out on a stand-alone test setup commissioned in 2008, as well as on the C04 antenna. These tests demonstarted superior tracking performance of the system. Based on these tests, the procurement for commissioning this system on four antenna has begun. At the same time,

antenna try out tests for a PC/104 based digital position loop continued through the year. The interlock system on 10 more antennas has been upgraded to solid-state interlock system this year. The design on an integrated control board, the generic antenna control board, was carried out in colloboration with BARC control group. A meeting of experts from outside the group was held last year to evaluate the upgrade efforts and work out the best interface between the different upgraded component. *[Suresh Sabhapathy, Shailendra Bagade, Sandesh Bhat, Trupti Ranka, Shriniwas Rao Beera, Amit Kumar, N V Nagarthnam and B C Joshi]*



(fig.1)

(fig.2)

(fig.3)

(fig.1.Brushless motor drive and controller rack at antenna driving base C04 antenna)
(fig.2. Brushless drives in anti backlash arrangement Load in LAB)
(fig.3. *Brushless motor driving the elevation axis - C04 antenna)*

Additions and Improvements to GMRT

A survey of all the MSEB transformers in the neighbourhood of the GMRT antennas has been carried out and a detailed list of all the faulty components that could lead to Radio Frequency Interference (RFI) has been prepared. This has been discussed with the MSEB, who have agreed to work with NCRA on replacing these components. A new RFI shielded shed for testing of Servo motors and control equipment is in the final stages of being set up. The fence around the central square region is being strengthened in a phased manner. A majority of the perimeter fence has now been strengthened, and the final phase is expected to be in the next financial year. Detailed specification for synchronization of the 3 generators required for the operation of the central square antennas in the event of an MSEB power failure have been made, and an work order for the same has been released. *[R. V. Swami, B. S. Patil, S. D. Patil]*

Detailed computer modeling of the GMRT antennas, using the STAAD and ANSYS packages has been done (in collaboration with Tata Consulting Engineers), and reports generated on the stress patterns on the members under different loading conditions, as well as on the stiffness and moment of inertia

parameters of the antenna. This will be used for the generating a new SERVO model for the antenna as well as for evaluating possible schemes for improvement of the antenna surface. Manufactures for the highly specialized "cherry picker", a high lift platform for accessing the antenna focus have been identified and detailed discussions are on going with them regarding the manufacture of new cherry pickers for the GMRT. Some turnbuckles used to keep the wire rope of the antennas in tension have rusted, and a procedure for replacement of these at height has been developed and tested. *[H. S. Kale, M. Somwanshi, M. Patil]*

Control & Monitor Systems for the GMRT :

As part of the GMRT upgrade, a prototype version of a new control and monitor system has been developed. The hardware part of the system uses the RCM 4000 based "Rabbit" micro-processor card as the basic control and monitor unit at the antennas, which will be connected to the central control facility at the observatory via ethernet links over the optical fibers that connect to each antenna.

A prototype card has been built and the original control and monitor software (written in assembly language) has been ported on to the new processor, using "Dynamic C". Almost all the commands have been implemented and tested in the lab, and the set-up has been optimised for performance. In a parallel development, a new control and monitor program that understands higher order commands sent from the main control and monitor software over ethernet link, and implements the details via the Rabbit card, has been delivered and tested in the lab. This version allows any telnet client or web browser to send commands and retrieve monitoring information.

The higher level software that runs on the main control and monitor computers (one each at the antennas and one in the central facility) has also undergone major improvements. Several new features have been added to this software : multi-user and multi-subarray capability, automation of MCM device driver insertion in the kernel, reduction of the response time of the status information from the antennas, and successful porting from FC3 to FC9 operating system. The improved software was tested successfully with 3 GMRT antennas to control and monitor the servo system, feed positioning system, antenna base receiver and sentinel system of the antennas.

In addition, several improvements have been carried out to the existing Online control and monitor system that is in regular use at the GMRT; these have helped significantly in improved monitoring, fault localisation and debugging of problems in different sub-systems at the antenna base. *[R.Balasubramaniam, S.Nayak, Charu Kanade, Jitendra Kodilkar, Naresh Sisodiya, C.Satheesh, B.Rajendran, Madhav Misal]*

GMRT proposal management system and online archive:

A next generation online proposal management and data archive system (called NAPS) has been developed in collaboration with Virtual Observatory- India. Starting with Cycle 18, the full featured proposal management system has been used for proposal submission as well as proposal review by the GTAC and external reviewers. The companion online archive system (COA) is about to be released.*[Yogesh Wadadekar, Jayaram Chengalur, Mangesh Umbarje, Shekhar Bachal, Sachin Sherkar, Jayprakash Kamble, Deepak Bhong, with the VO-India team]*

RADIO PHYSICAL LABORATORY AND WINTER SCHOOL

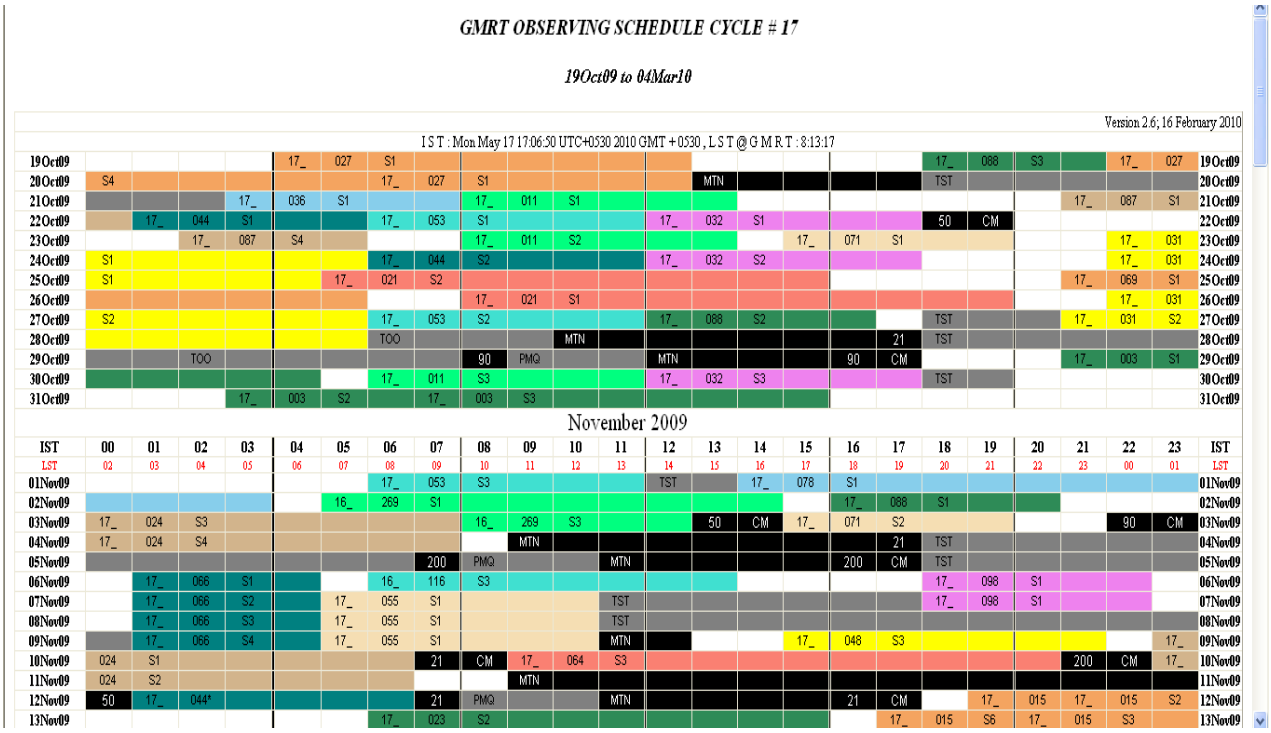
The Radio Physics Laboratory (RPL), a joint collaborative effort between IUCAA and NCRA, has been functioning in the NCRA East Campus since May 2007 with active co-operation from IUCAA. Experimental complement of three courses was provided by RPL this year, which included a course on Introductory Astronomy conducted for Physics Department of University of Pune by NCRA and IUCAA jointly. In addition, the laboratory also undertook conducting experiments for college students, particularly for students from IISER, Mohali. RPL hosted the second radio astronomy winter school for College and University students (RAWSC-09) between December 21 - 29, 2009, which received an enthusiastic response from college students. An affordable radio telescope, using off the shelf satellite dish and receivers, was designed and used for solar observations .

The telescope costs less than Rs 2000 and can be made by any college student. More experiments using this telescope are being prepared and it is expected to provide a platform for exposing a much larger student community to radio astronomy. A quagi antenna operating at 408 MHz was designed and tested. *[B. C. Joshi, D J Saikia, and Mohsin Madki with J. Bagchi, Nishikant Jadhav and D Bhattacharya]*

GMRT TIME ALLOCATION

The GMRT has been open to international users since January 2002. Proposals are invited every six month for observing cycles running from April to September and October to March. On an average about 60 proposals are received each cycle. The received proposals are sent for peer review, based on which time allocation is made by the independent GMRT time allocation committee (GTAC). A total of 73 and 78 proposals were received in cycles 16 and 17 and GTAC allocated time to 59 and 60 proposals respectively. The allocated time is then scheduled at NCRA. Some statistics for the proposals received in Cycles 16 and 17 are shown in the attached figure.

Starting from Cycle 17 a new online display for the observing schedule (shown in figure) has been developed by NCRA personnel. The display has a facility to summarise the proposal information important to observatory. Local observing help was provided to first time users. If observations were cancelled or corrupted due to system faults, then the observatory made efforts to reschedule them. Several Target of Opportunity (TOO) observations of highly transient phenomena (e.g. Supernovae explosions and gamma ray bursts), as well as observations of sources of high current scientific interest, were carried out under the director's discretionary time (DDT).



GMRT OBSERVING SCHEDULE CYCLE # 17

19Oct09 to 04Mar10

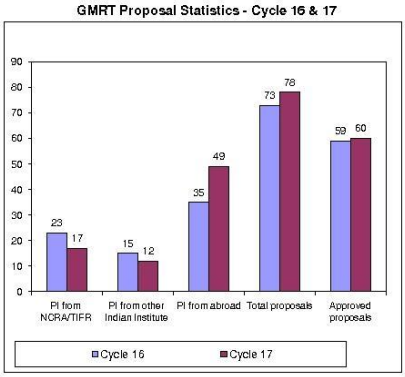
Version 2.6; 16 February 2010

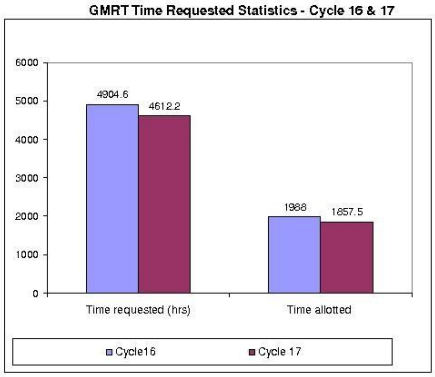
I S T : Mon May 17 17:06:50 UTC+0530 2010 GMT + 0530 , L S T @ G M R T : 8:13:17

19Oct09					17_	027	S1												17_	088	S3		17_	027	19Oct09
20Oct09	S4						17_	027	S1					MTN					TST						20Oct09
21Oct09				17_	036	S1			17_	011	S1												17_	087	S1	21Oct09
22Oct09		17_	044	S1			17_	053	S1				17_	032	S1				50	CM					22Oct09
23Oct09			17_	087	S4				17_	011	S2					17_	071	S1					17_	031	23Oct09
24Oct09	S1						17_	044	S2				17_	032	S2								17_	031	24Oct09
25Oct09	S1					17_	021	S2														17_	069	S1	25Oct09
26Oct09									17_	021	S1												17_	031	26Oct09
27Oct09	S2						17_	053	S2				17_	088	S2				TST			17_	031	S2	27Oct09
28Oct09							TOO				MTN							21	TST						28Oct09
29Oct09			TOO						90	PMQ			MTN				90	CM				17_	003	S1	29Oct09
30Oct09							17_	011	S3				17_	032	S3				TST						30Oct09
31Oct09				17_	003	S2		17_	003	S3															31Oct09

November 2009

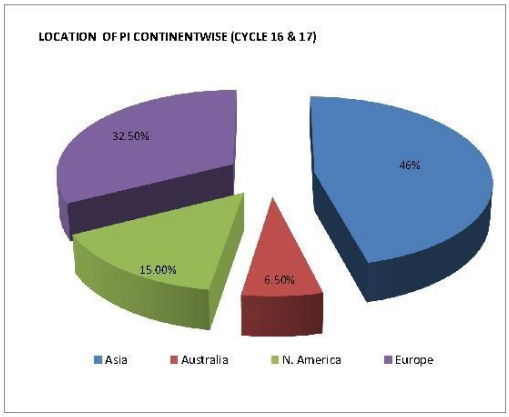
IST	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	IST
LST	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	LST
01Nov09							17_	053	S3				TST		17_	078	S1								01Nov09
02Nov09						16_	269	S1									17_	088	S1						02Nov09
03Nov09	17_	024	S3						16_	269	S3			50	CM	17_	071	S2					90	CM	03Nov09
04Nov09	17_	024	S4							MTN								21	TST						04Nov09
05Nov09								200	PMQ			MTN					200	CM	TST						05Nov09
06Nov09		17_	066	S1			16_	116	S3										17_	098	S1				06Nov09
07Nov09		17_	066	S2		17_	055	S1				TST							17_	098	S1				07Nov09
08Nov09		17_	066	S3		17_	055	S1				TST													08Nov09
09Nov09		17_	066	S4		17_	055	S1				MTN				17_	048	S3						17_	09Nov09
10Nov09	024	S1						21	CM	17_	064	S3										200	CM	17_	10Nov09
11Nov09	024	S2								MTN															11Nov09
12Nov09	50	17_	044*					21	PMQ			MTN					21	CM		17_	015	17_	015	S2	12Nov09
13Nov09							17_	023	S2									17_	015	S6	17_	015	S3		13Nov09





Observing Cycles 16 & 17

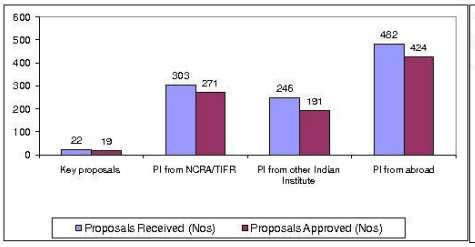
Country (PI)	No of Proposals
Australia	10
Austria	2
Canada	4
China	1
Denmark	1
France	1
Germany	1
India	68
Ireland	1
Italy	4
Japan	1
Mexico	1
Poland	4
Russia	3
Spain	2
The Netherland	11
UK	19
USA	17
Total	**151**

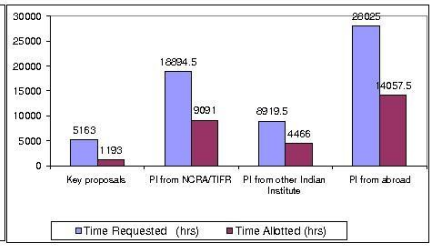


GMRT PROPOSAL STATISTICS - OBSERVING CYCLES 1 TO 17

Categories	Proposals Received (Nos)	Proposals Approved (Nos)	Time Requested (hrs)	Time Allotted (hrs)
Key proposals	22	19	5163	1193
PI from NCRA/TIFR	303	271	18894.5	9091
PI from other Indian Institute	246	191	8919.5	4466
PI from abroad	482	424	28025	14057.5
Total	**1053**	**905**	**61002**	**28807.5**

GMRT PROPOSAL STATISTICS - OBSERVING CYCLES 1 TO 17





NATIONAL AND INTERNATIONAL INVOLVEMENT

Ishwara-Chandra C. H

Member, Scientific Organising Committee, Workshop on exploration of Radio Universe - 2010, Gorakhpur University, February 2010.

J N Chengalur

Member of International SKA Science Working Group.

Member of the High Performance Computing in Observational Astronomy : Requirements and Challenges, Pune, October 12 to 16, 2009

Member of GMRT Time Allocation Committee

Member of the JNC-IUCAA Academic Committee

Member of the Nomination Committee, ASI

Yashwant Gupta

Member of the Scientific Advisory Committee of the Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune, January 1, 2009 to December 31, 2013.

Member of the editorial team for the proceedings of the conference "The Low-Frequency Radio Universe", published in 2009 as Volume 407 of the Astronomical Society of the Pacific Conference Series (along with Prof. D.J. Saikia, Prof. D.A. Green and Prof. T. Venturi).

Member of the Scientific Organising Committee of the international conference on "High Performance Computing in Observational Astronomy : Requirements and Challenges", Pune, October 12 to 16, 2009 (along with Prof. D. Bhattacharya of IUCAA and Dr. V. Sundararajan of CDAC)

Gopal Krishna

Adjunct Professor, ARIES (Nainital)

Nimisha Kantharia

Served on the Scientific Organising Committee of the 2009 IAU Joint Discussion on 'Hot Interstellar Matter in Elliptical Galaxies'.

Participating Commissions: 28 on Galaxies and 34 on Interstellar Medium. The JD was held during the IAU GA in August 2009 in Brazil.

P.K.Manoharan

Member of the National Advisory Committee for 7th Asia Oceania Geosciences Society Conference 2010.

Editor of Advances in Geoscience, Solar-Terrestial Section 2009-10.

Member of Organizing Committee, Commission 49, International Astronomical Union.

Member of Scientific Steering Committee, CAWSES – India, Phase II Programme

Chief Convener for Session on Solar-Terrestrial Sciences, Asia Oceania Geosciences Society 6th Conference, Singapore, July 2009.

D.J. Saikia

Associate Editor of the Bulletin of the Astronomical Society of India

Member of the advisory committee for the Space Physics Centre, Kolkatta

Member of the Australia Telescope Time Allocation Committee

Member of the Australia Telescope Users Committee

Member of the Scientific Organizing Committee of the 25th Texas Symposium on Relativistic Astrophysics to be held in Heidelberg, December 6-10, 2010

Member of the Indo-French Astronomy Network (IFAN) committee

Yogesh Wadadekar

Participated in PrepSKA related work to produce a SKA concept design review document on the Control and Monitor system for the Square Kilometer Array.

Attend the WP2 meeting in Oct. 2009 and the SKA 2010 conference in March 2010, Manchester.

LOC member for High Performance Computing in Astronomy - Requirements and Challenges, Pune, 12-16 October 2009

VISITS

Ishwara-Chandra C. H

The Inter-University Centre for Astronomy and Astrophysics, Pune, Visiting Scientist, August 2009 – February 2010.

Sunita Barve

Visiting Faculty at Tilak Maharashtra Vidyapeeth, Gultekdi, Pune , 2009-2010 for Masters in Library and Information Science Program.

Yashwant Gupta

Kodaikanal Observatory to participate in the Kodaikanal Summer School of the Indian Institute of Astrophysics, June 18-19, 2009.

DAVV University, Indore to participate in the National Conference of Shanti Swarup Bhatnagar Award winners, July 17-19, 2009.

CASPER meeting, Capetown, South Africa, September 28 - October 2, 2009 :
(also visited G.J. Shelton, Mekhala Muley, B. Ajithkumar)

Manchester, UK for participating in the SKA Science and Engineering Committee (SSEC-3) meeting and the PrepSKA meeting, October 26-31, 2009

Cambridge University, UK for collaborative research work and also delivered a colloquium, November 1-5, 2009.

EU-India Workshop on Research Infrastructures at New Delhi, January 11-12, 2010

Manchester, UK for participating in (i) the SKA-2010 meeting and (ii) the SKA Science and Engineering Committee (SSEC-4) meeting, March 22-28, 2010.

Nissim Kanekar

University of California, Santa Cruz, USA; February 2010

National Radio Astronomy Observatory, Socorro, USA; February 2010

National Radio Astronomy Observatory, Green Bank, USA; March 2010

Pravin Raybole

RFI 2010 Mitigation workshop, Groningen, The Netherlands,29th - 31st March 2010

Subhashis Roy

Interstellar Matter and Star Formation: A Multi-Wavelength Perspective, workshop, Hyderabad from October 5-7, 2009.

D.J. Saikia

Distinguished Visitor at the Australia Telescope National Facility, Marsfield, Sydney, Australia, from mid-May to mid-November, 2009

Australia Telescope Compact Array, Narrabri, Australia, 7th to 11th June 2009, and 7th to 15th September 2009

Molonglo Observatory, Queanbeyan, Canberra, Australia, 15th to 17th September, 2009

Parkes Observatory, Parkes, Australia, 22nd to 25th September, 2009

Swinburne University of Technology, Melbourne, Australia, 14th and 15th October 2009

Mount Stromlo Observatory, Canberra, Australia, 5th and 6th November 2009

Visiting Professor, ICRAR, University of Western Australia, Australia from mid-November 2009 to early May 2010

Bunker Bay Quay West Resort, Australia, to attend a workshop on Widefield HI and optical surveys, 15th to 18th November, 2009

Yogesh Wadadekar

University of Birmingham, England , 2-5 November 2009

AWARDS AND DISTINCTIONS

Jayaram N. Chengalur

Elected Fellow, National Academy of Sciences

Gopal Krishna

Elected Fellow, Indian National Science Academy

P.K. Manoharan

Elected as the Section President of Solar and Terrestrial Science, Asia-Oceania Geosciences Society (2009-2012)

INVITED TALKS IN CONFERENCES AND MEETINGS

Ishwara-Chandra C. H

Workshop on *Galaxy Astronomy* , M.G.University, Kottayam, November 2009.

Workshop on *Exploration of Radio Universe - 2010*, Gorakhpur University February 2010.

Advance workshop on Astronomy and Astrophysics, North Bengal University, April 2010.

J.N.Chengalur

HI searches for DLAs, Invited Talk, IAU JD14, The ISM of galaxies in the far infrared and sub-mm, Rio de Janeiro, Brazil 12-14 Aug 2009.

GMRT and opportunities for collaboration in Radio Astronomy , Invited talk, Indo-Russian workshop on collaboration in Astronomy & Astrophysics, Moscow, 11 Sep 2009.

The faint irregular galaxy GMRT Survey, Invited Talk, Nearby Galaxies conference, SAO, Russia, 13-18 Sep 2009.

HI absorption surveys, Invited talk, SKA WP2 meeting, Manchester, UK, 29-31 Oct 2009.

Searching for HI emission from distant galaxies, Cosmic Reionization workshop, Allahbad, 16-20 Feb. 2010.

The Giant Meterwave Radio Telescope: Overview and some results, Science day public talk, R&DE Dighi, 26 Feb 2010.

Dwarf Galaxies as Cosmological Probes, Colloquium, Dept. of Physics, Indian Institute of Science, Bangalore, 5 Mar 2010.

Yashwant Gupta

Challenges and directions in Astrophysics using Multi-Core Processors and GPU Computing at Xperience 2009 meeting of PICT, Pune, April 4, 2009.

Public talk on *Some Important Milestones in Radio Astronomy,* Nehru Centre, Mumbai, December 12, 2009.

P.K.Manoharan

Invited talk on *Interplanetary Scintillation Measurements at Ooty- large-scale solar wind structures*, Remote Sensing of the Inner Heliosphere Workshop, Aberystwyth University, UK, May 5 – 8, 2009

Invited talk on *Whole Heliospheric Interval: Three-dimensional Solar Wind*, JD-16, IAU General Assembly, Rio de Janeiro, Brazil, August 14, 2009.

Invited talk on *Solar, Solar Wind Studies and Space Weather Aspects*, CAWSES-India Phase II Science programme Workshop, National Atmospheric Research Laboratory, Gadanki, July 9 – 11, 2009.

Invited Colloquium on *Radio Astronomical Facilities and Space Weather Studies at NCRA*, India at Instituto Nacional de Pesquisas Espaciais (INPE), Divisão de Astrofísica, Brazil, August 27, 2009.

Invited Colloquium on *Solar and Space Weather Studies at Ooty*, at Universidade do Vale do Paraíba, Brazil, August 26, 2009.

Invited Colloquium on *Large-Scale Structures of Quiet and Transient Solatr Wind*, at University of Alabama, Huntsville, USA, September 2, 2009.

Invited Colloquium on *Evolution of Solar Wind in the Inner Heliosphere*, at Goddard Space Flight Center, NASA, Greenbelt, Maryland, USA, September 8, 2009.

Invited lectures on *Current Solar Cycle and its Peculiar Characteristics*, Indian Academy of Sciences Endowment Lecture, School of Physics, Madurai Kamaraj University, on July 31, 2009.

Invited lecture on *Radio Sounding of Solar Corona and Heliosphere*, Center for Excellence in Basic Sciences, Mumbai University, January 12, 2010.

Rajaram Nityananda

Galactic Dynamics: an overview for physicists, 14th July 2009, Perimeter Institute, Ontario, Canada

Pravin Raybole

External sources of RFI at the GMRT: Methods for control and co-existence with commercial users, RFI2010 Mitigation Workshop, The Netherlands, 29th March 2010.

Subhashis Roy

Studies of the ISM using the GMRT in the Interstellar Matter and Star Formation: A Multi-Wavelength Perspective, workshop in Hyderabad

D.J. Saikia

Gas loss processes and galaxy interactions: a few case studies, Galaxy Metabolism, 22nd-26th June 2009, AAO-ATNF Southern Cross Conference, Sydney

Diffuse non-thermal emission in radio sources, Science with SKAMP Workshop: Widefield Spectroscopy of the Southern Radio Sky, 16th-17th September 2009, Molonglo Observatory, Queanbeyan, Canberra

Noise considerations, 23rd September 2009, ATNF Radio Astronomy School, Parkes, 21st-25th September 2009

CONFERENCE ORGANIZED BY SCHOOL/DEPT./GROUP

High Performance Computing In Observational Astronomy : Requirements And Challenges. Pune**,** *October 12 To 16, 2009.*

This international conference was jointly organised by NCRA, IUCAA and CDAC. The main theme was to discuss computationally intensive techniques important for different branches of astronomy. The meeting, attended by more than 100 participants, brought together professionals in the areas of astronomy, statistical analysis, signal processing and computer science, including a significant presence and sponsorship from the IT industry in India. It has led to firming of very useful collaborations between

astronomy institutions and industry partners, which are likely to be of relevance for large international projects like the SKA.

The 6th Library and Information Services in Astronomy (LISA VI), Pune**,** *14-17 February 2010***:**
An international conference was held during 14-17 February 2010 at IUCAA, Pune. LISA VI was organized jointly by the members of the Forum for Resource Sharing in Astronomy (FORSA) libraries and hosted jointly by NCRA and IUCAA, Pune. The theme of the conference was "21st Century Astronomy Librarianship : From New Ideas to Action" and conference discussed issues concerning the future of librarianship, web 2.0/3.0, open access, digital preservation and virtual observatory. The scientific sessions scheduled on 16 February 2010, was held at GMRT-TIFR, Narayangaon and participants were given a tour of the radio telescope. The conference was attended by more than 100 participants, with more than 50 participants from abroad representing 18 countries.

NON DAE RESEARCH PROJECTS

Chengalur, J.N.

Gas and Star Formation in the Lowest mass Galaxies, DST-RFBR, 2009-2010
(*with Patra, N.; Roychowdhury, S.; Karchentsev, I.D.; Kaisin, S.S.; Kaisina, E.I.; Nasonova, O.G.; Pustilnik, S.A.; Sharina, M.E.)*

Chengalur, J.N.

Gas in Galaxies in the Distant Past, DST-AISRF, 2009-2011
(*with Frank Briggs, P.Lah, M.Colless)*

Y. Gupta

Development of the GMRT for pulsar astrophysics, and Square Kilometre Array demonstration, DST funded project under the Indo-Australian Science & Technology Programme of cooperation, 1 July 2008 to 30 June 2011
(with J. N. Chengalur, J. Roy, J. Prasad)

P.K. Manoharan

Operational Space Weather Forecasts, CAWSES-India Programme (Climate And Weather *of the* Sun-Earth System), ISRO Project, 2007-2009.

Study of Origin of Three-Dimensional Solar Wind and Propagation of Coronal Mass Ejections from Sun to 1 AU, CAWSES-India Programme, ISRO Project, 2007-2009.

PUBLICATION

In Journals

Abazajian, Kevork N.; …… Wadadekar, Yogesh; …..
The Seventh Data Release of the Sloan Digital Sky Survey, *Astrophysical Journal* Supplement, 182**,** 543 (2009)

Bagchi, Joydeep; Jacob, Joe; Gopal-Krishna; Werner, Norbert; Wadnerkar, Nitin; Belapure, Jaydeep; Kumbharkhane, A. C.
A diffuse bubble-like radio-halo source MRC0116+111: imprint of AGN feedback in a low-mass cluster of galaxies, *Monthly Notices of the Royal Astronomical Society*, 399, 601 (2009)

Barway, Sudhanshu; Wadadekar, Yogesh; Kembhavi, Ajit K.; Mayya, Y. D.
Near-infrared bulge-disc correlations of lenticular galaxies, 2009 , *Monthly Notices of the Royal Astronomical Society* , 394, (1991)

Benz, A.O.; Monstein, C.; Meyer,H.; Manoharan, P.K.; Ramesh, R. ; Altyntsev, A. ; Lara, A.; Paez, J.; Cho, K.-S. ,
A World-Wide Net of Solar Radio Spectrometers: *e-CALLISTO, Earth, Moon, and Planets*, vol 104, 277-285, 2009.

Bhardwaj, A.; Ishwara-Chandra, C. H.; Udaya Shankar, N.; Misawa, H.; Imai, K.; Miyoshi, Y.; Tsuchiya, F.; Kondo, T.; Morioka, A.
GMRT Observations of Jupiter's Synchrotron Radio Emission at 610 MHz. *Astronomical Society of the Pacific Conference Series*, 407, 369 (2009)

Bhattacharyya, B.; Gupta, Y.; Gil, J.
Exploring the remarkable subpulse drift and polarization properties of PSR B0818-41, *Monthly Notices of the Royal Astronomical Society*, 398, 1435, (2009)

Bisi, M. M.; Jackson, B. V.; Clover, J. M.; Manoharan, P. K.; Tokumaru, M.; Hick, P. P. and Buffington, A.
Annales Geophysicae., vol 27, p 4479–4489, (2009)

Joshi, Bhuwan; Veronig, Astri; Cho, K.-S.; Bong, S.-C.; Somov, B.V.; Moon, Y.-J.; Lee, Jeongwoo; Manoharan, P. K. and Kim, Y.H.
Magnetic reconnection during the two-phase evolution of a solar eruptive flare, *Astrophysical Journal*, vol. 706, p1438–1450, (2009)

Chandola Yogesh; Saikia D.J.; Gupta Neeraj.
HI gas in the rejuvenated radio galaxy 4C29, 30403, 269 (2010)

Clarke, T. E.; Blanton, E. L.; Sarazin, C. L.; Anderson, L. D.; Gopal-Krishna; Douglass, E. M.; Kassim, N. E.
Racing Multiple Generations of Active Galactic Nucleus Feedback in the Core of Abell 262 *Astronomical Journal*, 697, 1481 (2009)

Dutta, P.; Begum, A.; Bharadwaj, S.; Chengalur, J. N.
A study of interstellar medium of dwarf galaxies using HI power spectrum analysis, *Monthly Notices of the Royal Astronomical Society*, 398, 887, (2009)

Dutta, P.; Begum, A.; Bharadwaj, S.; Chengalur, J. N.
Probing Turbulence in the Interstellar Medium of Galaxies, *Astronomical Society of the Pacific Conference Series*, 407, 83, (2009)

Dutta, P.; Begum, A.; Bharadwaj, S.; Chengalur, J. N.
The scaleheight of NGC 1058 measured from its HI power spectrum, *Monthly Notices of the Royal Astronomical Society*, 397, L60, (2009)

Ekta B.; Jayaram N. Chengalur
HI in isolated extremely metal-deficient galaxies, *Monthly Notices of the Royal Astronomical Society*, 403, 295 (2010)

Ekta B.; Jayaram N. Chengalur
When are extremely metal-deficient galaxies extremely metal-deficient? *Monthly Notices of the Royal Astronomical Society* (accepted) eprint arXiv:1003.6026 , (2010)

Ekta, B.; Chengalur, J. N.; Pustilnik, S.;
High Resolution H I Observations of the Very Metal-Poor System SBS~0335-052, *Astronomical Society of the Pacific Conference Series*, 407, 95, (2009)

Ekta, B.; Pustilnik, S. A.; Chengalur, J. N.
HI in very metal-poor galaxies: the SBS 0335-052 system, *Monthly Notices of the Royal Astronomical Society*, 397, 963, (2009)

George, S. J.; Ishwara-Chandra, C. H.
Extended Sources from Deep GMRT 150 MHz Observations, *Astronomical Society of the Pacific Conference Series* 407, 47, (2009)

Gharote, M. S.; Deshpande, A. M.; Lodha, S. P.; Kantharia, N. G.; Wadadekar, Y. G.; Katore, S. N.; Rao, A. P.
Automated Telescope Scheduling, *Astronomical Society of the Pacific Conference Series*,407, 438 (2009)

Gopal-Krishna; Wiita, Paul J.
Galaxy shells and the structure of radio galaxies: Clues from Centaurus A (NGC 5128) *New Astronomy*, 15, 96 (2010)

Goyal, Arti; Gopal-Krishna; Joshi, S.; Sagar, R.; Wiita, Paul J.; Anupama, G. C.; Sahu, D. K.
Optical variability of radio-intermediate quasars, *Monthly Notices of the Royal Astronomical Society*, 401, 2622 (2010)

Goyal, Arti; Gopal-Krishna; Anupama, G. C.; Sahu, D. K.; Sagar, R.; Britzen, S.; Karouzos, M.; Aller, M. F.; Aller, H. D.
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Hess, K. M.; Pisano, D. J.; Wilcots, E. M.; Chengalur, J. N.
Anomalous H I in NGC 2997, *The Astrophysical Journal* , 699, 76, (2009)

Ishwara-Chandra, C. H.; Sirothia, S. K.; Wadadekar, Y.; Pal, S.; Windhorst, R.
Deep GMRT 150-MHz observations of the LBDS-Lynx region: ultrasteep spectrum radio sources, *Monthly Notices of the Royal Astronomical Society* , 405, 436-446. (2010)

Ishwara-Chandra, C. H.; Sirothia, S. K.; Pal, S.; Wadadekar, Y.
A Program to Search for Ultra-Steep Spectrum Radio Sources with GMRT , 2009 *Astronomical Society of the Pacific Conference Series*, 407, 43 (2009)

Jamrozy, M.; Saikia, D. J.; Konar, C.
4C02.27: a quasar with episodic activity? *Monthly Notices of the Royal Astronomical Society*, 399, L141 (2009)

Joshi, B. C.; McLaughlin, M.A.; Lyne, A.G.; Ludovici, D.A.; Pawar, N.A.; Faulkner, A.J.; Lorimer, D.R.; Kramer, M. Davies, M.L.
Discovery of three new pulsars in a 610-MHz pulsar survey with the GMRT, *Monthly Notices of the Royal Astronomical Society*, 398, 943 (2009)

Kanekar, N.; Chengalur, J.N.; Ghosh, T.
Probing Fundamental Constant Evolution with Redshifted Conjugate-satellite OH Lines *Astrophysical Journal*, 716, L23, (2010)

Kanekar, N.; Prochaska, J. X, Ellison, S. L.; Chengalur, J. N.
Probing Fundamental Constant Evolution with Neutral Atomic Gas Lines , *Astrophysical Journal*, 712, L148 (2010)

Kanekar, N.; Smette, A.; Briggs, F. H.; Chengalur, J. N.
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Kanekar, N.; Prochaska, J. X.; Ellison, S. L.; Chengalur, J. N.
A search for HI 21cm absorption in strong MgII absorbers in the redshift desert, *Monthly Notices of the Royal Astronomical Society*, 396, 385, (2009)

Kantharia, N. G.; Das, M.; Gopal-Krishna
GMRT Detection of a New Wide-Angle Tail (WAT) Radio Source Associated with the Galaxy PGC 1519010 *Journal of Astrophysics and Astronomy*, 30, 37 (2009)

Konar C.; Hardcastle M.J.; Croston J.H.; Saikia D.J.
The dynamics of the giant radio galaxy 3C457, *Monthly Notices of the Royal Astronomical Society* , 400, 480 (2009)

Lah, P.; Pracy, M. B.; Chengalur, J. N.; Briggs, F. H.; Colless, M.; de Propris, R.; Ferris, S.; Schmidt, B. P.; Tucker, B. E.
The HI gas content of galaxies around Abell 370, a galaxy cluster at z = 0.37, *Monthly Notices of the Royal Astronomical Society*, 399, 1447, (2009)

Lecavelier Des Etangs, A.; Sirothia, S. K.; Gopal-Krishna; Zarka, P.
GMRT radio observations of the transiting extrasolar planet HD 189733 b at 244 and 614 MHz, *Astronomy & Astrophysics*, 500, 51 (2009)

Liu, Li-Jia; Zhang, Xi-Zhen; Li, Jian-Bin; Manoharan, P. K. ; Liu Zhi-Yong and Peng, Bo. Observations of interplanetary scintillation with a single-station mode at Urumqi, *Research in Astronomy and Astrophysics*, Vol. 10, 577–586, (2010).

Macquart, J-P.; Kanekar, N.; Frail, D. A.; Ransom, S. A
High-frequency Search for Pulsars within the Central Parsec of Sgr A * *Astrophysical Journal*, 715, 939, (2010)

Mangalam, A.; Gopal-Krishna; Wiita, Paul J.
The changing interstellar medium of massive elliptical galaxies and cosmic evolution of radio galaxies and quasars, *Monthly Notices of the Royal Astronomical Society*, 397, 2216 (2009)

Mantovani F.; Rossetti A.; Junor W.; Saikia D.J.; Salter C.J.
Radio Polarimetry of 3C119, 3C318, and 3C343 at milliarcsecond resolution, *Astronomy & Astrophysics*, in press (arXiv:1005.2950M) (2009)

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Nandi S.; Pirya A.; Pal S.; Konar C.; Saikia D.J.; Singh M.
A multifrequency study of the large radio galaxies 3C46 and 3C452, *Monthly Notices of the Royal Astronomical Society* , 404, 433 (2010)

Pal, S.; Ishwara-Chandra, C. H.; Rao, A. P.
Multifrequency Observation of Cygnus X--3 at the Time of Giant Flare in 2006 May-June. *Astronomical Society of the Pacific Conference Series* 407, 277 (2009)

Pankaj, Kumar.; Manoharan, P.K.; Wahab Uddin.
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Paredes, J. M.; and 12 colleagues
Radio continuum and near-infrared study of the MGRO J2019+37 region, *Astronomy and Astrophysics* 507, 241-250 (2009).

Pen, Ue-Li; Chang, Tzu-Ching; Hirata, C. M.; Peterson, J. B.; Roy, J.; Gupta, Y.; Odegova, J.; Sigurdson, K.
The GMRT EoR experiment: limits on polarized sky brightness at 150 MHz, *Monthly Notices of the Royal Astronomical Society*, 399, 181 (2009)

Rao, A.R. et al.
RT-2 Detection of Quasi-periodic Pulsations in the 2009 July 5 Solar Hard X-ray Flare, *Astrophysical Journal*, Vol. 714, p.1142-1148, (2010)

Rawat, Abhishek; Wadadekar, Yogesh; De Mello, Duilia
Rest-Frame UV Versus Optical Morphologies of Galaxies Using Sérsic Profile Fitting: The Importance of Morphological K-Correction , *Astronomical Journal*, 695.1315 (2009)

Rawat, A.; Wadadekar, Y.; de Mello, D.
Rest frame UV vs. optical morphologies of galaxies: Important implications to high-z results, *IAUS*, 254P, 57 (2009)

Roy, N.; Chengalur, J. N.; Bharadwaj, S.; Dutta, P.
Turbulence in Cold Neutral ISM and in Supernova Remnants, *Astronomical Society of the Pacific Conference Series*, 407, 272, (2009)

Roychowdhury, S.; Chengalur, J. N.; Begum, A.; Karachentsev, I. D.
Gas and Star Formation in Extremely Faint Dwarf Galaxies, *Astronomical Society of the Pacific Conference Series*, 407, 106, (2009)

Roychowdhury, S.; Chengalur, J. N.; Begum, A.; Karachentsev, I. D.
Star formation in extremely faint dwarf galaxies, *Monthly Notices of the Royal Astronomical Society*, 397, 1435, (2009)

Saikia D.J.; Jamrozy M.
Recurrent activity in Active Galactic Nuclei, *Bulletin of the Astronomical Society of India*, 37, 63 (2009)

Saikia D.J.
Highlights from the observatories, *Bulletin of the Astronomical Society of India*, 38, 53 (2010)

Salter C.J.; Saikia D.J.; Minchin R.; Ghosh T.; Chandola Y.
The Discovery of Host Galaxy H I Absorption in CTA 21, *Astrophysics Journal (Letters)*, 715, L117 (2010)

Sirothia, S. K
Rapid mapping of the sky at 240MHz using the antennas of the Giant Metrewave Radio Telescope, *Monthly Notices of the Royal Astronomical Society*, 398, 853S, (2009)

Sirothia, S. K.; Dennefeld, M.; Saikia, D. J.; Dole, H.; Ricquebourg, F.; Roland, J.
325-MHz observations of the ELAIS-N1 field using the Giant Metrewave Radio Telescope, *Monthly Notices of the Royal Astronomical Society*, 395, 269S (2009)

Sirothia, S. K.; Saikia, D. J.; Ishwara-Chandra, C. H.; Kantharia, N. G.
Deep low-frequency observations with the Giant Metrewave Radio Telescope: a search for relic radio emission. *Monthly Notices of the Royal Astronomical Society* 392, 1403-1412 (2009)

Sirothia, S. K.; Saikia, D. J.; Ishwara-Chandra, C. H.; Kantharia, N. G.
A GMRT Search for Relic Radio Emission, *Astronomical Society of the Pacific Conference Series* 407, 204, (2009)

Thomas R.M.C.; Gangadhara R.T.
Absolute emission altitude of pulsars: PSRs B1839+09, B1916+14 and B2111+46 (accepted for publication in *Astronomy & Astrophysics*) arXiv1003, 4825 (2010)

Thomas R.M.C.; Gupta Y.; Gangadhara R.T.
Understanding the geometry and rotation effects on pulsar intensity profiles (accepted for publication in, *Monthly Notices of the Royal Astronomical Society* , arXiv1003.4687 (2010)

Vikram, Vinu; Wadadekar, Yogesh; Kembhavi, Ajit K.; Vijayagovindan, G. V.
Quantitative measure of evolution of bright cluster galaxies at moderate redshifts, *Monthly Notices of the Royal Astronomical Society* , 401L..39

Yanny, Brian; Rockosi, Constance; ….. Wadadekar, Yogesh; …...
SEGUE: A Spectroscopic Survey of 240,000 Stars with g = 14-20, *Astrophysical Journal*, 137, 4377 (2009)

In Proceedings

Bagchi, J.; Gopal-Krishna; Krause, M.; Konar, C.; Joshi, S.
A Giant Radio Jet of Very Unusual Polarization in a Single-Lobed Radio Galaxy *Astronomical Society of the Pacific Conference Series*, 407, 200 (2009)

Bagchi, J.; Jacob, J.; Gopal-Krishna; Wadnerkar, N.; Belapure, J.; Werner, N.; Kumbharkhane, A. C.
Diffuse Bubble-Like Radio-Halo Emission in MRC~0116+111: Imprint of AGN Feedback in a Distant Cluster of Galaxies, *Astronomical Society of the Pacific Conference Series*, 407, 255 (2009)

Bhattacharyya, Bhaswati ; Gupta, Y. and Gil, Janusz
Wide Profile Drifting Pulsars: An Elegant way to Probe Pulsar Magnetospheres . The Low-Frequency Radio Universe Asp Conference Series, Vol.,407, Edited By: D.J.Saikia, D.A.Green, Y.Gupta and T. Venturi, San Francisco, *Astronomical Society of the Pacific*, p313 (2008)

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Sengupta, C.; Dwarakanath, K.S. and Saikia, D.J.
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Sirothia, S. K.; Saikia, D. J.; Ishwara-Chandra, C. H.; Kantharia, N. G.
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325-MHz Observations of the ELAIS-N1 Field, *Astronomical Society of the Pacific Conference Series*, 407, 27S (2009)

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Srivastava, S.; Kantharia, N. G.; Srivastava, D. C.; Mishra,A.; Srivastava, A. K. Ananthakrishnan,S.
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Srivastava, Anoop K. ; Kantharia, N. G. ; Srivastava, D. C. ; Ananthakrishnan, S. ; Kodilkar, J.; Redij, A; Dhanya, Srivastava, Shweta and Mishra, Alka.
Radio Continuum Studies of Halos of Edge-on Disk Galaxies , The Low-Frequency Radio Universe Asp Conference Series, Vol.,407, Edited By: D.J.Saikia, D.A.Green, Y.Gupta And T. Venturi, San Francisco, *Astronomical Society of the Pacific*, p216 (2008)

Thomas, R. M. C. ; Gupta, Y. and Gangadhara, R. T.
Understanding Pulsar Emission Profiles from Geometry and Rotation Effects . . 323

LECTURES/LECTURE COURSES GIVEN ELSEWHERE

Sunita Barve

Digital Libraries,
Maharashtra Academy of Engineering, Alandi, Pune ,21st February 2010, during National Level Workshop on Library Automation and Building digital library-LABDL-10 program.

An analysis of SLA-PAM mailing list :What is SLA-PAM doing?
LISA VI international conference on 17th February 2010 , IUCAA, Pune , 14th-17th February 2010.

Open source digital library software , Cummins College of Engineering, Pune , 10th November 2009 during their National Staff Development Program.

Digital Library and Managing digital Libraries, Jayakar Library, Pune University, during the refresher course on New Trends in Library and Management on 9th November 2009.

J.N.Chengalur

Radio Astronomy, 4 lectures at the National Initiative on Undergraduate Science, 8-9 June 2009

Yashwant Gupta

Pulsars and Radio Astronomy, Kodaikanal Summer School, Kodaikanal, June 18-19, 2009.

The Magnetism of Neutron Stars, National Conference of Shanti Swarup Bhatnagar Award winners at DAVV University, Indore, July 17, 2009.

The GMRT : Past, Present and Future, TIFR, Mumbai, July 29, 2009.

A real-time software backend for the GMRT : towards hybrid backends, CASPER workshop, Capetown, South Africa, September 30, 2009.

Developments in India relevant for the SKA, SKA2010 meeting, Manchester, UK, October 29, 2009.

The Giant Metre-wave Radio Telescope : An Overview, Some Recent Results & Future Plans, Cambridge University, UK, November 3, 2009.

The GMRT and India's Plans for the SKA, EU-India Workshop on Research Infrastructures, New Delhi, January 11, 2009.

B.C.Joshi

Radio Astronomy Experiments in RPL at NCRA Radio Astronomy School, May 18, 2009

Experiments , Radio Physics Laboratory and NCRA Radio Astronomy SchoolMay 18-29, 2009

Radio Pulsars , NCRA Radio Astronomy School, May 25 - 27, 2009

Pulsars , NCRA Radio Astronomy Winter School, December 26, 2009

Data Analysis , NCRA Radio Astronomy Winter School, December 21, 2009

Nissim Kanekar

Single dish radio astronomy, Radio Astronomy Winter School (2 lectures)
Inter- University Centre for Astronomy and Astrophysics, Pune, December 2009.

N G Kantharia

Spectral Lines, Radio Astronomy School students 25^{th} - 26^{th} May 2009.

P.K.Manoharan

Sun and Space Weather, Special Programme on Astronomy, Vellalar College for Women, Erode, March 10, 2010.

Course on *Eruptive Phenomenon on the Sun*, and Refresher Course on *Recent Trends in Physics*, Madurai Kamaraj University, November 3 – 23, 2009.

Rajaram Nityananda

Quantum Mechanics II, IISER, Pune, (30 lectures) July – November 2009

Basic Astronomy and Astrophysics, IISER, Mohali (9 lectures), November 2009.

Pravin Raybole

External sources of RFI at GMRT: Methods to control and co-existence with commercial users
RFI 2010 Mitigation workshop, Groningen, The Netherlands,29th - 31st March 2010

Subhashis Roy

Radio frequency observations and the central region of the Galaxy, Burdwan University, Burdwan, West Bengal, 13 October 2009.

Distance scale and its estimation in Astronomy, IUCAA ,Winter school participants, 21 December 2009

Multifrequency observations and resolution in radio astronomy IUCAA ,Winter school participants , 23 December 2009

Radio astronomy in the context of Multifreqency observations and resolution, St. Xavier's college, Kolkata, 13 March 2010,

D.J. Saikia

Radio galaxies: small and large,
ATNF Colloquium, Sydney, 30th September 2009

Environments and evolution of radio galaxies,
Swinburne University of Technology Colloquium, Melbourne, 15th October 2009

Radio galaxies: some aspects of their environment and evolution,
Mount Stromlo Observatory Seminar, Canberra, 6th November 2009

Radio galaxies: an introduction
ICRAR Vacation Students Programme, University of Western Australia, Perth, 17th December 2009

Recurrent activity in Active Galactic Nuclei,
Australia Telescope Large Area Survey Meeting, 16th February 2010

Radio galaxies and quasars: some aspects of their environment and evolution,
ICRAR Colloquium, University of Western Australia, Perth, 18th February 2010

Active galaxies and black holes
Lecture course (5 lectures) to third-year Physics students, University of Western Australia, 22nd-31st March 2010

Gopal Krishna

The Radio Sky, at the Radio Astronomy School May, 18-22, 2009

Chandreyee Sengupta,

HI and star formation in interacting galaxies, September 1, 2009

Yogesh Wadadekar

Gravitational lensing (strong and weak)
Talk at Astronomy Olympiad Training Camp 2009 ,HBCSE-TIFR , 12 May 2009.
Conducted two tutorials and a lab session.

Multiwavelength Astronomy
Eextended talk at IUCAA-NCRA VSP/VSRP/RAS program, 16 May 2009.
Hubble Space Telescope at IUCAA VSP/Refresher Course on 12 June 2009.

Archive design and metadata models
ISRO Astrosat software workshop , 3 July 2009.

The SDSS Data Archive Server
IUCAA reunion pre-meeting , August 10, 2009

Galaxies in UV/optical, near-infrared and radio
1st IUCAA Reunion meeting, August 2009

Morphological Evolution in galaxy clusters
Seminar at the School of Physics and Astronomy, University of Birmingham, 3 Nov 2009

Python for astronomical data analysis,
mini course (8 contact hours) at GMRT on Sep 8 and Sep 15, 2009.

WEB PUBLICATIONS

Rao, A.R. et al.
RT-2 Detection of Quasi-Periodic Pulsations in the 2009 July 5 Solar Hard X-ray Flare, arXiv:1003.3992 vol, 2009

Sirothia, S. K.; Saikia, D. J.; Ishwara-Chandra, C. H.; Kantharia, N. G.
GMRT radios sources around J0916+6348 field (Sirothia+, 2009) 2009, Cat..73921403S

S. Ramya, U. K. Gurgubelli, N. G. Kantharia, G. C. Anupama, T. P. Prabhu,
Detection of radio emission at 610 MHz from the supernova SN2008bx in the BCD galaxy I Zw 97, The Astronomer's Telegram, #2227, 2009.

LECTURES BY VISITORS

Alain Lecavelier, *IAP, France,*
Evaporation of extrasolar planets and beyond,
17-Apr-09

C. R. Subrahmanya, *RRI, Bangalore,*
Revival of Cosmology with the Ooty Radio Telescope,
24-Apr-09

J. V. S. Harikrishna, *Pune University,*
Experimental and Stimulation studies on single and Split Modes in Flexible Electromagnetically Coupled Microstrip Notch Filters,
5-May-09

Shankar Ghosh,*Tata Institute of Fundamental Research, Mumbai*
Using gaming cards to do video Microscopy experiments,
25-May-09

Stewart Eyers, *University of Central Lancashire, UK,*
The development of a Born-Again Giant,
25-Jun-09

Eduardo Ibar, *The Royal Observatory, UK,*
The deep multi-frequency radio imaging in the Lockman Hole using the GMRT and VLA,
26-Jun-09

S. Roychaudhury, A. Ahuja, N. Swaminathan, *Tata Research Development and Design Centre, Pune*
The current implementation of the SACE-based GMRT antenna Controller,
30-Jun-09

Habib Kosroshahi, *IPM, Iran,*
Fossil galaxy groups: New findings from observations and Stimulations,
17-Jul-09

Ian Browne, *University of Manchester, UK,*
A dichotomy in jet orientations in elliptical galaxies,
28-Aug-09

Ue-Li Pen, *CITA, Canada*
The GMRT EOR Experiment: A progress update,
4-Sep-09

T. N. Rengarajan, *Tata Institute of Fundamental Research, Mumbai (*retd.),
Radio-Far-infrared Correlation in Ultra Luminous Infrared Galaxies and the role of Secondary Cosmic Ray Electrons,
14-Sep-09

Peter Biermann, *MPIfR, Bonn and University of Alabama,*
Ultra-high energy particles and cosmic ray electrons/positrons from massive star explosions,
3-Nov-09

Peter Biermann, *MPIfR, Bonn and University of Alabama,*
Dark Matter and Black holes in the universe,
6-Nov-09

Gregg Hallinan, *National University of Ireland Galway,*
Looking for a pulse: the Search for Radio Emission from Extrasolar Planets,
9-Nov-09

John Ford, *Green Bank Telescope, West Virginia, USA,*
The Green Bank Observatory of the US National Radio Astronomy Observatory,
19-Dec-09

GRADUATE COURSES

B.C.Joshi

Astronomy and Astrophysics-I, (16 lectures), Department of Physics, University of Pune, August – December 2009

Ishwara-Chandra C. H

Extragalactic Astronomy – II, IUCAA-NCRA graduate school (14 lectures), March - May 2010.

J.N.Chengalur

Astronomical Techniques II, IUCAA-NCRA graduate school

D.Mitra

Introduction to Astronomy and Astrophysics II, IUCAA-NCRA graduate school

Rajaram Nityananda

Astrophysics II (Cosmology)

Yogesh Wadadekar

Taught Astronomical Techniques I (Incoherent Detection) course, IUCAA-NCRA graduate school, Jan-Feb 2010.

PH.D. THESES/M.SC. THESES

Bhaswati Bhattacharyya (Ph.D. Thesis)
Single pulse studies of wide profile drifting Pulsars – a probe of pulsar magnetosphers, IISc., Bangalore (JAP)
(Guide: Yashwant Gupta)

Nirupam Roy (Ph.D. Thesis)
Between the Stars: The multiphase turbulent ISM, NCRA, Pune
(Guide: J.N.Chengalur)

Sandeep Kumar Sirothia (Ph.D. Thesis)
Deep low-frequency surveys using the Giant Metrewave Radio Telescope, NCRA, Pune
(Guide: D.J.Saikia)

Vishal Kumar Gajjar (M.Sc. Theses)
Nulling Behaviour of PSR J1738-2330, NCRA, Pune.
(Guide: B C Joshi)

Chaithra Prasad (M.Sc. Thesis)
Estimation of sensitivity of GMRT by redetecting known pulsars in a harmonic search
Department of Physics, University of Pune
(Guide: B.C.Joshi)

Mayuresh Surnis (M.Sc. Thesis)

Search for New radio Transient with special RFI excision techniques in GMRT 325 MHz search

Department of Physics, University of Pune

(Guide: B.C.Joshi)

VSRP PROJECTS/TRAINING OF COLLEGE STUDENTS

Shweta Bhagwat, a first year IISER student, VSRP Reading project, May to July 2009.
(Guide: Nimisha Kantharia)

Rakesh Kumar,VSRP, Integrated pulse profile evolution of binary pulsar B1957+20 along its orbit, *Indian Institute Of Technology, Kharagpur*
(Guide: B.C.Joshi)

Shakti Magar who developed a GMRT news submission interface and the backend database.
(Guide: Nimisha Kantharia)

P. Nithya, Bharathiar University, Coimbatore, The many faces of Centaurus, VSRP Project, May - July, 2009.
(Guide : Yogesh Wadadekar)

Snehal Shekatkar , Pune University, M.Sc. Student , *On Circular Polarization in Pulsars: An Elementary Theoretical Approach***,** VSRP Project, May -July, 2009.
(Guide: Rejii Mathew C. Thomas)

Suriya Priya V. 2nd year M.Sc. Student, Lady Doak College, Madurai Kamaraj University, Project theses on *Neutrinos from the Sun and Solar Model*, May – July 2009.
(Guide: P.K.Manoharan)

Vijayalakshmi,R. 2nd year M.Sc. Student, Lady Doak College, Madurai Kamaraj University, Project theses on *Neutrinos from the Sun and Solar Model*, May – July 2009.
(Guide: P.K.Manoharan)

POPULAR SCIENCE ARTICLES/LECTURES

G.Swarup

ब्रह्मांड की सैर, 10 February 2009, GMRT, Khodad

Yogesh Wadadekar

Written an article titled khagolshastranyaachyaa aayushyaatiila eka ratra published in chaatra prabodhan, a student magazine published by Dnyana Prabodhini, Pune.

Top 10 discoveries of the Hubble Space telescope, Canteen talk NCRA, Pune and Khodad, October 5 and 8 2009 in English and Marathi respectively.

Top 10 discoveries of the Hubble Space Telescope IYA 2009 lecture series talk at the Shivneri Foundation School, Khanapur on 20 Nov. 2009

हबल दुर्बीणीचे Top 10 शोध Nov 20 talk by Yogesh Wadadekar at Shivneri foundation school, Khanapur (near Junnar)

Organised as part of the IYA 2009 activity titled 100 hours of Astronomy a series of 3 stargazing programs from 3-5 April 2009 at the following locations.

3rd April: stargazing at Bhute Patil High School, Junnar.
4th April: stargazing at R. P. Sabnis School, Narayangaon
5th April: stargazing at Khodad High School, Khodad.

Each program was from 1900 to 2200 hours and about 3000 locals benefited from these programs.

RADIO & TV PROGRAMMES

P.K. Manoharan

Solar Eclipse, July 15, 2009, All India Radio, Ooty.

Yogesh Wadadekar

Answered astronomy questions from listeners in "navalaaeecha khagol" (Episodes 21 and 39) of IYA 2009 special series produced by All India Radio, Pune.

ANY OTHER INFORMATION

Sunita Barve

Participated as a key resource person in the workshop organised by Maharashtra Academy of Engineering, Alandi, Pune on KOHA and DSpace Open Source Software from 18th February 2010 to 22nd February 2010. There were total 65 participants from all over India for this workshop. Delivered talks and practical sessions to all participants on KOHA and DSpace software.

Conducted workshop on KOHA Library Automation Software from 13th July 2009 to 15th July 2009 at NCRA, Pune. Total 25 participants attended the workshop and for the first time librarians were taught how to install Linux Operating System.

Nimisha Kantharia

A new informative online format for the GMRT Observing schedule has been developed. Also programmes to edit the schedule have been developed and are being used. *(Santaji Katore and N. G. Kantharia)*

HBCSE initiated a programme of short clips on a simple question which is answered by astronomers

through the country which was to be aired on TV during the IYA. Nimisha Kantharia featured in the clip on Galaxies

OBITUARIES

M.C. Balraj,
Tradesman-H (joined as Tradesman B in Sep 1977).
Expired on 12 Dec 2009.

J.S. Langhi,
Tradesman-D (joined as Tradesman B in Aug 1995).
Expired on 2 Jan 2010.

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