Contents

Sun and Heliosphere

Current State of Reduced Solar Activity: Intense Space Weather Events in the Inner Heliosphere:

We present a study of 21 geomagnetic storms, occurred during 2011–2017 in association with the propagation of coronal mass ejections (CMEs). These storms are selected with the minimum storm intensity of -100 nT or less and are distributed from the maximum to the minimum of the weak solar cycle 24. We identify and investigate these storms driving CMEs (halo and partial halo CMEs) by combining EUV and white-light images in the near-Sun region, interplanetary scintillation images in between the Sun and the Earth (from the Ooty Radio Telescope), and *in-situ* measurements at the near-Earth orbit. These CMEs cover a wide range of initial speeds, ~180 to 2680 km/s. For about 50% of the CMEs, the fast initial speed at the near-Sun region does not correlate with the final speed at the near-Earth orbit. A comparison of travel time of CME to 1 AU with the observed initial/final speeds and estimated initial speed suggests that a large fraction of fast initial speeds could possibly be due to the sudden expansion of the CME into a relatively low pressure interplanetary medium. Most of the geomagnetic storms (i.e., 19 storms) have been caused by the strong intrinsic magnetic field of the CME and only 2 storms are produced by the sheath region between the arrival times of interplanetary shock and CME. A relatively less compression on the CME due to the low-speed background solar wind and a rapid radial decline of magnetic field could have also led to low geo-effectiveness. An examination of thermal and magnetic energy densities at 1 AU suggests that the propagation of CMEs corresponding to these storms has been influenced by the magnetic energy possessed by the CME [P.K. Manoharan, K. Mahalakshmi, A. Johri, B.V. Jackson, D. Ravikumar, K. Kalyanasundaram, S.P. Subramanian, A.K. Mittal]

The intercalibration of IPS data sets from ISEE and Ooty observatories:

The important advantage among the ISEE (Nagoya University, Japan) and Ooty IPS (National Centre for Radio Astrophysics, TIFR, India) observations is the same observing frequency of 327 MHz, which is best suited to probe solar wind density structures at heliocentric distances in the range of ~20–250 solar radii. The IPS measurements from these institutions have provided an impressive data base for nearly four solar cycles. The steerability of the Ooty Radio Telescope is useful to get simultaneous scintillation observations between Ooty and ISEE. The comparison of a large number of simultaneous measurements available between Ooty and ISEE yielded several interesting results: (a) Scintillation index curves have been established for ISEE observations; (b) For a given source, when the time difference between Ooty and ISEE observations is less than 30-min of time, the IPS power spectra from these observatories are compared and they look identical, which has been confirmed on more than one source. In excess of 90% of the simultaneous power spectra, which in fact exceed couple of hundreds, compare excellently well and the sensitivity difference between the telescopes has also been evidently shown. This result is a phenomenal one that two independent observatories separated by a large geographical position provide the identical results on solar wind. It essentially validates the importance of single station IPS measurements in space weather monitoring studies; (c) Despite the fact that more 90% of the simultaneous spectra match identically, few spectra between Ooty and ISEE show some remarkable difference, which has some comprehensive information on the solar wind structures passing along the individual line of sight to the radio source. More analysis will be taken up to explore the physical properties of the solar wind [P.K. Manoharan, M. Tokumaru]

Propagation of Coronal Mass Ejections Observed During the Rising Phase of Solar Cycle 24:

In this study, we investigate the interplanetary consequences and travel time details of 58 coronal mass ejections (CMEs) in the Sun-Earth distance. The CMEs considered are halo and partial halo events of width >120°. These CMEs occurred during 2009 – 2013, in the ascending phase of the Solar Cycle 24. Moreover, they are Earth-directed events that originated close to the centre of the solar disk (within about ±30° from the Sun's centre) and propagated approximately along the Sun-Earth line. For each CME, the onset time and the initial speed have been estimated from the white-light images observed by the coronagraphs onboard the LASCO/SOHO space mission. These CMEs cover an initial speed range of ~260 - 2700 km/s. For these CMEs, the associated interplanetary shocks (IP shocks) and interplanetary CMEs (ICMEs) at the near-Earth environment have been identified from in-situ solar wind measurements available at the OMNI data base. Most of these events have been associated with moderate to intense IP shocks. However, these events have caused only weak to moderate geomagnetic storms in the Earth's magnetosphere. The relationship of the travel time with the initial speed of the CME has been compared with the observations made in the previous Cycle 23, during 1996 - 2004. In the present study, for a given initial speed of the CME, the travel time and the speed at 1 AU suggest that the CME was most likely not much affected by the drag caused by the slow-speed dominated heliosphere. Additionally, the weak geomagnetic storms and moderate IP shocks associated with the current set of Earth-directed CMEs indicate magnetically weak CME events of Cycle 24. The magnetic energy that is available to propagate CME and cause geomagnetic storm could be significantly low [S.M. Ibrahim, P.K. Manoharan, A. Shanmugaraju]

The Worldwide Interplanetary Scintillation (IPS) Stations (WIPSS) Network October 2016 Observing Campaign: Initial WIPSS Data Analyses:

Interplanetary Scintillation (IPS) allows for the determination of velocity and a proxy for plasma density to be made throughout the corona and inner heliosphere. Where sufficient observations are undertaken, the results can be used as input to the University of California, San Diego (UCSD) three-dimensional (3-D) time-dependent tomography suite to allow for the full 3-D reconstruction of both velocity and density throughout the inner heliosphere. By combining IPS results from multiple observing locations around the planet, we can increase both the temporal and spatial coverage across the whole of the inner heliosphere and hence improve forecast capability.

During October 2016, a unique opportunity arose whereby the European-based LOw Frequency ARray (LOFAR) radio telescope was used to make nearly four weeks of continuous observations of IPS as a heliospheric space-weather trial campaign. This was expanded into a global effort to include observations of IPS from the Murchison Widefield Array (MWA) in Western Australia and many more observations from various IPS-dedicated WIPSS Network systems. IPS data from LOFAR, ISEE, the MEXican Array Radio Telescope (MEXART), and, where possible, other WIPSS Network systems (such as LPI-BSA and Ooty Radio Telescope), have been used in this study and we present some initial findings for these data sets. We also make a first attempt at the 3-D reconstruction of multiple pertinent WIPSS results in the UCSD tomography. We will also highlight some of the potential future tools that make LOFAR a very unique system to be able to test and validate a whole plethora of IPS analysis methods with the same set of IPS data [Bisi et al.]

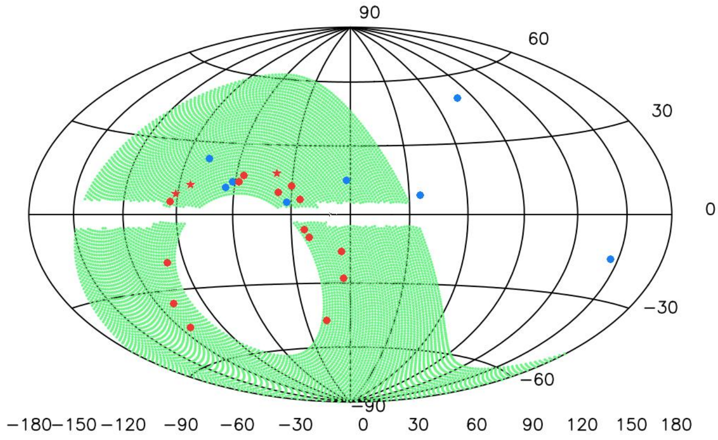
Space Weather Research – Indian perspective:

Space weather, just like its meteorological counterpart, is of extreme importance when it comes to its impact on terrestrial near- and far-space environments. In recent years, space weather research has acquired an important place as a thrust area of research having implications both in space science and technology. The presence of satellites and other technological systems from different nations in near-Earth space necessitates that one must have a comprehensive understanding not only of the origin and evolution of space weather processes but also of their impact on technology and terrestrial upper atmosphere. To address this aspect, nations across the globe including India have been investing in research concerning Sun, solar processes and their evolution from solar interior into the interplanetary space, and their impact on Earth's magnetosphere-ionosphere-thermosphere system. In India, over the years, a substantial amount of work has been done in each of these areas by various agencies/institutions. In fact, India has been, and continues to be, at the forefront of space research and has ambitious future programs concerning these areas encompassing space weather. This review aims at providing a glimpse of this Indian perspective on space weather research to the reader and presenting an up-to-date status of the same [A. Bhardwaj, T.K. Pant, R.K. Choudhary, D. Nandy, P.K. Manoharan]

Star and Pulsars

GMRT High Resolution Southern Sky (GHRSS) survey − A SKA pathfinder survey.

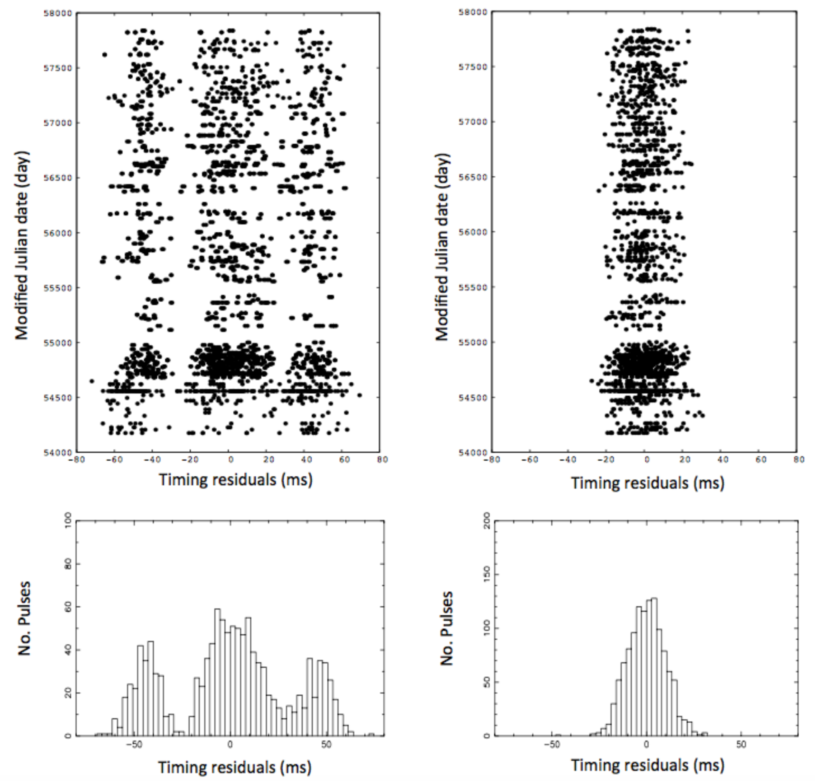
To bring out GMRT's potential in blind search for pulsars, I formed a team and started the GHRSS survey. We have discovered 17 pulsars from this survey including one millisecond pulsar and two mildly recycled pulsars. The pulsar per square degree discovery rate of the GHRSS survey is one of the highest for the off-galactic-plane surveys. With upgraded GMRT (uGMRT) time-domain survey sensitivity is expected to improve at least by a factor of two in 300−500 MHz band. We have started phase-2 of the GHRSS survey with the upgraded GMRT and have discovered 2 pulsars in the pilot phase. With total 360 hours of survey done, we have a discovery rate of 1 pulsar per 20 hours [B. Bhattacharyya, J. Roy, B. W. Stappers, T. Johnson, C. Llie, A. Lyne, M. Malenta, P. Weltrevrede, Jayaram Chengalur, S. Cooper, M. Keith, S. Kudale, M. McLaughlin, S. M. Ransom, P. S. Ray, B. Kaur]



Pulsars discovered by us with the GMRT between 2012−2017 from targeted and blind surveys. Fermi- directed discoveries − blue circles, GHRSS discoveries − red circles, most recent discoveries with GHRSS survey in last six months: red stars, sky coverage of Phase -1 of GHRSS survey – shaded region. Most of the pulsars discovered are |b| <20 degrees

A long term timing study of three Rotating Radio Transients (RRATs)

We present the longest-term timing study so far of three Rotating Radio Transients (RRATs) − J1819−1458, J1840−1419 and J1913+1330 − performed using the Lovell, Parkes and Green Bank telescopes over the past decade. We study long-term and short-term variations of the pulse emission rate from these RRATs and report a marginal indication of a long-term increase in pulse detection rate over time for PSR J1819−1458 and J1913+1330. For PSR J1913+1330, we also observe a two orders of magnitude variation in the observed pulse detection rates across individual epochs, which may constrain the models explaining the origin of RRAT pulses. In addition to bright RRAT pulses, we discovered a weak and persistent emission mode in PSR J1913+1330 [B. Bhattacharyya, A. G. Lyne, B. W. Stappers, P. Weltevrede, E. F. Keane,M. A. McLaughlin, M. Kramer, C. Jordan, C. Bassa]



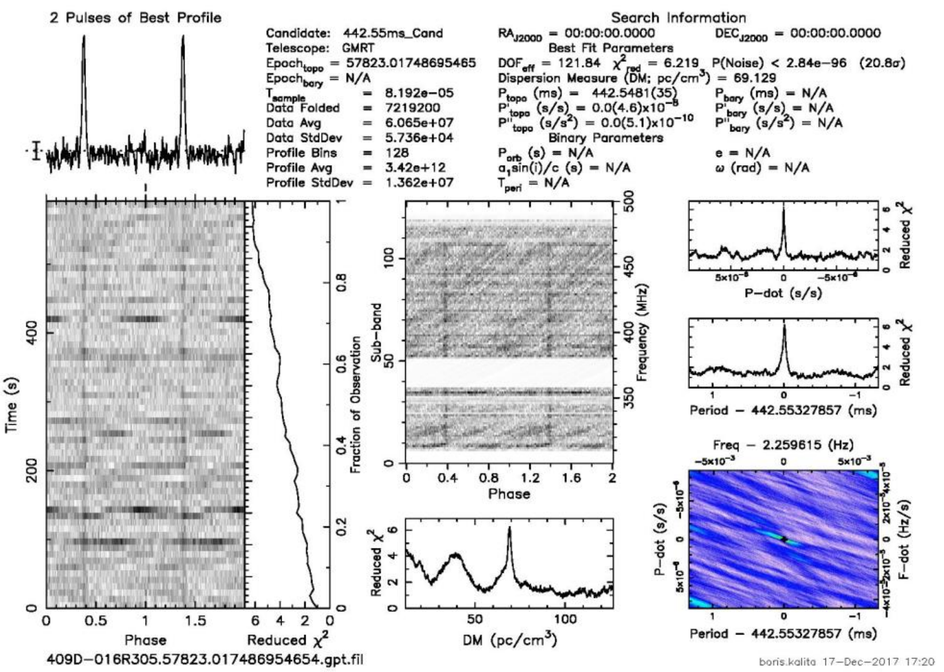
Left panel: The timing residuals from the TOAs from the Lovell and the Parkes observations at L-band of the individual pulses from PSR J1819−1458 from post-glitch observations (relative to the model in Table 2) for ~ 3900 days i.e. ~ 11 years, showing that the majority of TOAs are located in three clearly identifiable bands with the accumulated arrival time histograms shown below. Right panel: The same residuals, but with the TOAs in the early and late bands fitted using offsets of −43.2±1.5 ms and +46.1±1.4 ms relative to the central band, to produce unbanded residuals, with the accumulated arrival time histogram shown below. The rms of the residuals subsequently decreases from 31.4 to 8.9 ms.

Discovery of coherent radio emission in a magnetic star

Observations of more than 350 stars in Milky Way has revealed 10% massive stars to be magnetic (Wade et al. 2012, 2016). The magneto-hydrodynamic simulations have revealed that the stellar wind properties of magnetic stars are modified in important ways as compared to the winds of non-magnetic stars. Studying the radio emission at different frequencies reveal the magnetic field topology of the star. We have taken up a systematic study of all magnetic massive stars at low frequencies with the GMRT and high frequencies with the VLA. Our observations of HD 133880 revealed Electron Cyclotron Coherent Emission (ECME) at GMRT frequencies (Das et al. 2018), whereas the star shows gyrosynchrotron emission at higher radio frequencies. This is only the second magnetic star in which coherent radio emission has been detected. Further studies are being carried out to understand the nature of ECME emission. Our work was reported in MNRAS Letters (Das et al. 2018, MNRAS Letters 474, L61). Now we are carrying out low frequency survey of a sample of fast rotating stars to explore ECME phenomenon. [Barnali Das, Poonam Chandra, Gregg Wade and Matt Shultz]

Pilot Pulsar survey with upgraded GMRT

Taking advantage of enhanced sensitivity due to wide-band receivers, commissioned in the recent upgrade of the GMRT, a pilot uGMRT pulsar survey was initiated towards the end of 2016. This pilot survey covered 300 square degrees of sky near the Galactic center in 512 pointings observed in band 3 of uGMRT (300 - 500 MHz). The observations for this pilot survey were completed by March 2017. In the last year, a new search pipeline was developed and implemented in the high performance cluster at NCRA, for analyzing these data. This pipeline was used to analyze all



Discovery plot from the search analysis pipeline of the pilot uGMRT pulsar survey, showing the detection of the first new pulsar with the uGMRT. The pulsar has a period of 442.5 ms and a dispersion measure of 69.1 pc/cc, and shows up clearly in both the frequency and time domain plots, with very good signal to noise ratio. Follow-up observations have confirmed this new discovery.

observations by January 2018. The analysis resulted in a large number of candidates. Further algorithms were developed to eliminate candidates due to radio frequency interference, mitigate the effects of strong satellite interference from satellite such as Muos and other spurious periodicities, called ``birdies''. The pipeline was tuned based on detected birdies and a second pass of analysis was completed early this year. Apart from detecting known pulsars in the field, the survey has discovered the first new pulsar with the upgraded GMRT (as shown in the figure) which has been confirmed in follow-up observations. Several short-listed candidates are being examined by our collaboration, some of which are likely to be confirmed as new pulsars. Further follow up observations of the new pulsar and strong candidates are planned in future. Encouraged by these results, another pilot survey in band 4 (550-750 MHz) of a similar region of the sky is proposed this year to evaluate the most effective band of uGMRT for a future all-sky survey [Yashwant Gupta, Sushan Konar, Bhal Chandra Joshi, A. A. Deshpande, Abhimanyu Susobhanan, Alak Ray, Biplab Bijay, Biprateep Dey, Boris Kalita, Debades Bandyopadhyay, Debashish Jena, Dipankar Bhattacharya, Gururaj Wagle, Manjari Bagchi, Mayuresh Surnis, Paramasivan Arumugam, Sajad Ahmad Bhat, Sanjay Kudale, Vishal Gajjar, Yogesh Maan]

Indian Pulsar Timing Array Project

We initiated a project using the legacy Ooty Radio Telescope and the GMRT three years back to monitor a sample of 9 millisecond pulsars once every 20 days. These pulsar timing observations were aimed at establishing an Indian pulsar timing array experiment, similar to on-going international pulsar timing array (PTA) experiments. The main aim of PTAs is to detect nano-Hertz Gravitational waves. Around the same time, a parallel experiment to characterize and set-up precision timing with the upgraded GMRT (uGMRT) was started in November 2015. Both the experiments have now matured leading to improvements in observatory instrumentation and time and frequency standards. While the precision timing experiment with the uGMRT has demonstrated high precision timing capability of the uGMRT, the legacy experiment helped building our own timing solutions as well as development of analysis techniques for precision timing and Gravitational wave detection. The two experiments have been combined as a single Indian pulsar timing experiment (InPTA) since January 2018. This experiment monitors 20 pulsars once every fortnight and is yielding a timing precision of about 1 microsecond routinely for these pulsars. Throughout last year, monitoring observations were conducted with the legacy GMRT and the uGMRT at band 3, 4 and 5 apart from high cadence observations with the ORT at 334.5 MHz. A collaboration of 15 astronomers from five institutions, led by NCRA-TIFR astronomers, is currently analyzing the data obtained. We are also developing the required software pipeline to handle data for a larger sample of pulsars in future. Since January this year, InPTA collaboration has become an associate member of International Pulsar Timing Array (IPTA) consortium, which combines the efforts of PTA experiments around the world, and many of our members are actively contributing in IPTA working groups [Bhal Chandra Joshi, Achamveddu Gopakumar, Yashwant Gupta, Manjari Bagchi, M A Krishnakumar, Prakash Arumugasamy, P. K.

Manoharan, Arun Naidu, Mayuresh Surnis, Abhimanyu S, Suryarao Bethapudi, Shantanu Desai, Kishalay De, Neelam Dhanda Batra, Yogesh Maan]

Augmenting Pulsar observing systems at ORT and pulsar monitoring program at ORT

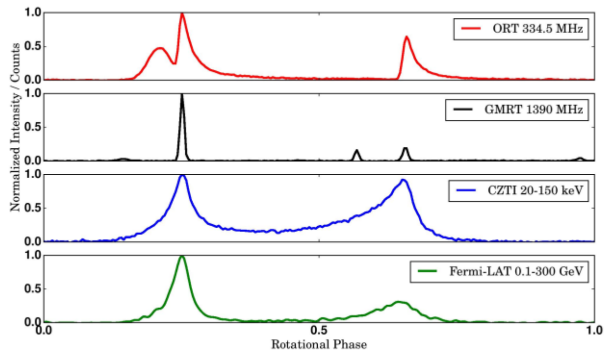
A program for monitoring pulsars was initiated in February 2016 with funding from Science and Engineering Research Board, Department of Science and Technology, Government of India. New instrumentation consisting of Rubidium standard, Global positioning receivers, data storage servers and data acquisition machines were procured under this program in 2016 to 2017. An uninterrupted power supply to provide 24 hour backup for the new time and frequency standards was procured this year. All these instruments are commissioned and are used for monitoring pulsars with high precision pulsar timing. Currently, about 40 pulsars are monitored regularly under this program, which has resulted in about seven refereed publications in the last two years [Bhal Chandra Joshi, P. K Manoharan, M. A. Krishnakumar]

Phase-resolved X-ray polarimetry of the Crab pulsar with the AstroSat CZT Imager

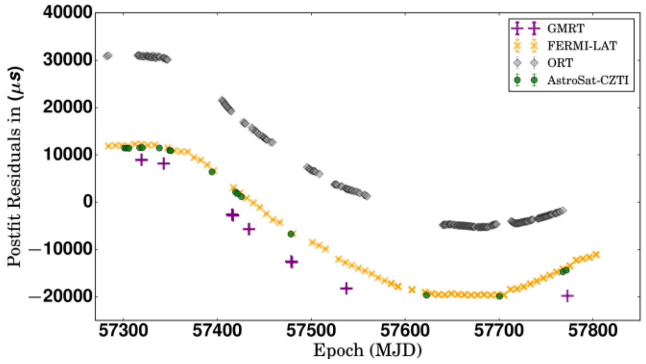
The Crab pulsar is a typical example of a young, rapidly spinning, strongly magnetized neutron star that generates broad-band electromagnetic radiation by accelerating charged particles to near light speeds in its magnetosphere. Details of this emission process so far remain poorly understood. Measurement of polarization in X-rays, particularly as a function of pulse phase, is thought to be a key element necessary to unravel the mystery of pulsar radiation. However, such measurements are extremely difficult. To date, Crab is the only pulsar to have been detected in polarized X-rays and the measurements have not been sensitive enough to adequately reveal the variation of polarization characteristics across the pulse. Soon after the launch of the first Indian multi-wavelength astronomy satellite AstroSat, this pulsar was observed repeatedly with Cadmium-Zinc-Telluride Imager in coordination with TIFRs two ground based radio telescopes - the ORT and the GMRT. This resulted in the most sensitive measurements to date of polarized hard X-ray emission from the Crab pulsar and nebula in the 100-380 keV band. The radio observations with the ORT and the GMRT provided accurate pulse ephemeris allowing for the first time a phase resolved measurements of hard X-rays of this pulsar. We confirm with high significance the earlier indication of a strongly polarized off-pulse emission. However, we also find a variation in polarization properties within the off-pulse region. In addition, our data hint at a swing of the polarization angle across the pulse peaks. This behaviour challenges the existing theoretical models of high-energy emission from pulsars [S. V. Vadawale, T. Chattopadhyay, N. P. S. Mithun, A. R. Rao, D. Bhattacharya, A. Vibhute, V. B. Bhalerao, G. C. Dewangan, R. Misra, B. Paul, Avishek Basu, Bhal Chandra Joshi, S. Sreekumar, E. Samuel, P. Priya, P. Vinod, S. Seetha]

Coordinated ORT-GMRT-ASTROSAT observations of PSR B0531+21 for calibration of timing offsets of CZTI instrument

CZTI is a hard X-ray telescope aboard Indian multi-wavelength mission AstroSat and operates over an energy range of 20-380 keV. The timing offset introduced in the data acquisition pipeline of this instrument is unknown and is required for time alignment of high energy time-series with those from ground based observatories. Soon after the launch of AstroSat mission, we conducted coordinated observations with the legacy GMRT at 1390 MHz and the ORT at 334.5 MHz of the bright X-ray and radio pulsar B0531+21 (Crab pulsar) to calibrate the timing offsets. PSR B0531+21 is a well studied bright pulsar with nearly aligned radio and hard X-ray pulse profiles. Observations with daily cadence were carried out at the ORT to obtain good timing solutions. Analysis of these data and archival



Average pulse profile of PSR B0531+21 obtained using phase coherent average over all data with different instruments used in this study. The data were aligned using the offsets estimated in this study. The larger peak is called as main-pulse, while the smaller peak is referred as inter-pulse. The panels show the average profiles obtained with FERMI archival data, the CZTI, the GMRT and the ORT from bottom panel to top respectively. The radio profile were obtained with the GMRT at 1390 MHz and with the ORT at 334.5 MHz



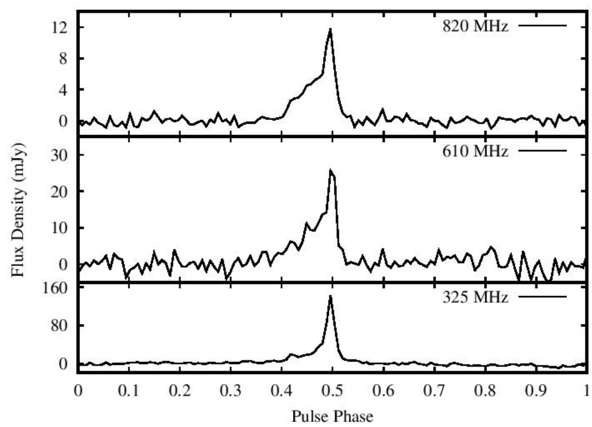
Plot of the phase connected TOAs from the Fermi-LAT (yellow cross markers), the ASTROSAT CZTI (green circles), the GMRT (purple plus markers) and the ORT (gray diamonds) observations. The phase connection was obtained with the high cadence TOAs derived from the ORT observations and then applied to TOAs from other telescopes. The systematic pattern in the timing residuals is due to timing noise. The TOAs for different telescopes are offset with each other due to relative delays in the data acquisition at each telescope.}

data from FERMI-LAT mission allowed full characterization of timing noise and Dispersion Measure variation seen in this pulsar. After correcting for these effects, we have determined relative offset of ASTROSAT-CZTI with respect to the ORT and the GMRT as -29 and -4 milliseconds respectively.

Figure 2 shows the resultant aligned profile of PSR B0531+21 from radio to high energies. [Avishek Basu, Bhal Chandra Joshi, Dipankar Bhattacharya, A R Rao A. Naidu, M. A. Krishnakumar, Prakash Arumugsamy, Santosh Vadawale, P.K. Manoharan, G.C. Dewangan, N.P.S. Mithun]

GMRT Galactic Plane Pulsar and Transient Survey and the Discovery of PSR J1838+1523:

We carried out a survey covering about 10% of the region between Galactic longitude 45 deg < l < 135 deg and Galactic latitude 1 deg < |b| < 10 deg with a dwell time of 1800 s. Last year, we reported the results of this blind pulsar survey carried out with the Giant Metrewave Radio Telescope at 325 MHz, which resulted in the detection of 28 pulsars. One of these, PSR J1838+1523 was previously unknown and has a period of 549 ms and a dispersion measure of 68 pc cm^-3. We also reported the timing solution of this pulsar obtained from multi-frequency timing observations carried out with the GMRT and the ORT. The measured flux density of this pulsar is 4.3 +- 1.8 and 1.2 +- 0.7 mJy at 325 and 610 MHz respectively. This implies a spectral index of -2 +- 0.8, thus making the expected flux density at 1.4 GHz to be about 0.2 mJy, which would be just detectable in the high frequency pulsar surveys like the Northern High Time Resolution Universe pulsar survey. This discovery underlines the importance of low frequency pulsar surveys in detecting steep spectrum pulsars, thus providing complementary coverage of the pulsar population. [Mayuresh P. Surnis, Bhal Chandra Joshi, Maura A. McLaughlin, Duncan R. Lorimer, Krishnakumar M. A., P. K. Manoharan, Arun Naidu]



Average profiles of PSR J1838+1523 at different frequencies. The profiles at 325 and 610 MHz were scaled using interferometric measurements, while the 820 MHz GBT profile was scaled using extrapolated flux density assuming a spectral index of -2. The effective integration times for the profiles are 0.5, 5 and 20 hours at 820, 610 and 325 MHz, respectively.}

Observations of high Dispersion Measure pulsars with Arecibo telescope.

The inhomogeneities in the inter-stellar medium scatter the pulsed emission from radio pulsars broadening the observed pulse. Measurements of this pulse scatter broadening constrains the nature of turbulence in the inter-stellar medium and its spectrum as this is related to a strong evolution of pulse scatter broadening with observing frequency. This evolution is well studied for pulsars with Dispersion Measure (DM) less than 500, particularly in our recent investigations with the ORT and the uGMRT. However, very few measurements are available for pulsars with DM greater than 500. Last year, we proposed and obtained observations on a sample of 9 such pulsars with the Arecibo telescope. DM of these pulsars range from 512 to 1274 pc/cc. We also obtained archival data from the Parkes radio telescope and the GMRT to enhance the final sample, which consisted of 29 pulsars with DM ranging 198 to 1274 pc/cc. This is the largest statistically significant sample of high DM pulsars, which has been investigated so far. In our preliminary results from analysis of these data, we find that DMs of some of the pulsars were different from that reported in the literature. These observations indicate that frequency scaling index of pulse scatter-broadening is consistent with Kolmogorov spectrum even for high DM pulsars contrary to what was reported about two decades back. Work is in progress to quantify evolution of pulse scatter-broadening with frequency and interpretation of these new results [M. A. Krishnakumar, Bhal Chandra Joshi, P. K. Manoharan]

Observations of scattering of low DM pulsars with LOFAR.

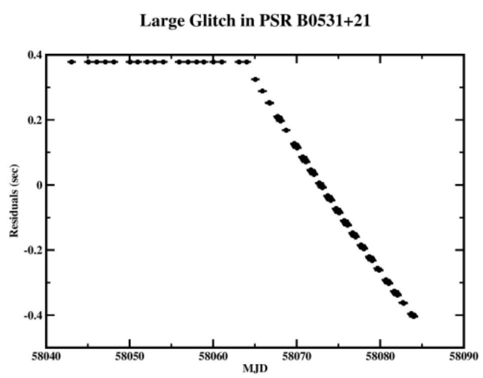
Scattering in the inter-stellar medium causes a severe broadening of pulsed emission from radio pulsars at frequency below 300 MHz. At the same time, pulse scatter-broadening also increases with Dispersion Measure (DM) of pulsar. While this leads to non-detection of pulsed emission in higher DM pulsars at low frequencies, lack of significant pulse scatter-broadening for pulsars with DM less than 50 pc/cc at observation frequencies greater than 300 MHz makes measurements of this effect difficult for such pulsars. As very few measurements were available for such pulsars, we observed a sample 8 pulsars using low band array of LOFAR last year between 30-80 MHz. We also obtained archival data for 10 pulsars observed using LWA (10-88 MHz) and 14 pulsars, which were observed using high band array (110-190 MHz) of LOFAR. With this unique sample of 29 pulsars covering a range of DM between 14 to 130 pc/cc, we have increased the sample of such measurements by about 60 \%. Our preliminary results hint at a frequency dependence of frequency scaling index of pulse scatter-broadening, with this index much steeper than expected Kolmogorov spectrum [M. A. Krishnakumar, Yogesh Maan, Bhal Chandra Joshi, P. K. Manoharan]

Simultaneous multi-frequency observations of single pulses from pulsars.

There is a small class of pulsars, which shows pulse nulling, sub-pulse drifting and profile mode-changes. The best example of this class are PSRs B0031-07 and B2319+60. In a recent study, we found two similar interesting pulsars. We have used the unique capability of the uGMRT to conduct simultaneous multi-frequency observations of PSRs J1822-2256 and J1901-0906 covering a frequency range from 250 to 1500 MHz to obtain high sensitivity data on single pulses for these pulsars. For PSR J1822-2256, no emission is detected in about 10 % of pulses. At least two drift modes and a possibly third rare mode, occur for 66, 21 and 2 % pulses respectively (P3 ~ 17, 7.5 and 5 P0 respectively). The three drift modes and the nulls occur concurrently from 250 to 1500 MHz. Modal average profiles are distinct with their widths increasing with drift rate. These sub-pulse drift related profile mode-changes can provide independent probes of beam geometry and polar gap physics. In addition, we also conducted observations of PSR J0934-5249 over 250 to 1500 MHz to investigate the memory of sub-pulse drift with pulse nulling. The analysis of this unique data set is currently in progress [Bhal Chandra Joshi, Arun Kumar Naidu, Vishal Kumar Gajjar, G. A. E. Wright]

Observations of largest glitch in Crab pulsar.

Crab pulsar (PSR B0531+21) is monitored about once every day as part of our routine pulsar monitoring program at the Ooty Radio Telescope. These observations are carried out at the central frequency of 326.5 MHz, with a 16-MHz pass-band. Our monitoring detected the largest glitch reported in this pulsar so far at MJD 58064. Our estimate of the fractional spin up is about (0.47+-0.07)E-6. The phase connected residuals with the pre-glitch solutions are shown in the figure [M. A. Krishnakumar, Bhal Chandra Joshi, Avishek Basu, P K Manoharan]



The largest ever detected glitch in Crab pulsar (PSR B0531+21) on MJD 58064 observed with the ORT

Detection of long nulls in PSR B1706-16, a pulsar with large timing irregularities:

Single pulse observations, characterizing in detail, the nulling behaviour of PSR B1706-16 are being reported for the first time in this paper. Our regular long duration monitoring of this pulsar reveals long nulls of 2-5 h with an overall nulling fraction of 31 ± 2 per cent. The pulsar shows two distinct phases of emission. It is usually in an active phase, characterized by pulsations interspersed with shorter nulls, with a nulling fraction of about 15 per cent, but it also rarely switches to an inactive phase, consisting of long nulls. The nulls in this pulsar are concurrent between 326.5 and 610 MHz. Profile mode changes accompanied by changes in fluctuation properties are seen in this pulsar, which switches from mode A before a null to mode B after the null. The distribution of null duration in this pulsar is bimodal. With its occasional long nulls, PSR B1706-16 joins the small group of intermediate nullers, which lie between the classical nulling pulsars and the intermittent pulsars. Similar to other intermediate nullers, PSR B1706-16 shows high timing noise, which could be due to its rare long nulls if one assumes that the slowdown rate during such nulls is different from that during the bursts [A. Naidu, B.C. Joshi, P.K. Manoharan, M.A. Krishnakumar]

Detection of radio emission from the gamma-ray pulsar J1732-3131 at 327 MHz

Although originally discovered as a radio-quiet gamma-ray pulsar, J1732-3131 has exhibited intriguing detections at decameter wavelengths. We report an extensive follow-up of the pulsar at 327 MHz with the Ooty radio telescope. Using the previously observed radio characteristics, and with an effective integration time of 60 h, we present a detection of the pulsar at a confidence level of 99.82 per cent. The 327 MHz mean flux density is estimated to be 0.5-0.8 mJy, which establishes the pulsar to be a steep spectrum source and one of the least luminous pulsars known to date. We also phase-aligned the radio and gamma-ray profiles of the pulsar, and measured the phase-offset between the main peaks in the two profiles to be 0.24 ± 0.06. We discuss the observed phase-offset in the context of various trends exhibited by the radio-loud gamma-ray pulsar population, and suggest that the gamma-ray emission from J1732-3131 is best explained by outer magnetosphere models. Details of our analysis leading to the pulsar detection, and measurements of various parameters and their implications relevant to the pulsar's emission mechanism are presented [Y. Maan, M.A. Krishnakumar, A.K. Naidu, S. Roy, B.C. Joshi, M. Kerr, P. K. Manoharan]

Galaxy

GMRT monitoring of the Black Hole X-ray Binary V404 Cygni during its 2015 outburst

We have used the GMRT to monitor the black hole binary system V404 Cygni during its flaring outburst in June 2015, at low frequencies, <= 1.4 GHz. We find the low-frequency radio emission of V404 Cygni to be extremely bright and fast-decaying in the outburst phase, with an inverted spectrum below 1.5 GHz and an intermediate X-ray state. The radio emission settles to a weak, quiescent state 11 days after the outburst, with a flat radio spectrum and a soft X-ray state. Combining the GMRT measurements with flux density estimates from the literature, we identified two peaks in the radio spectrum at 1.5-3 GHz on June 26.9 UT, indicating the presence of two synchrotron self-absorbed emitting regions, perhaps arising from two radio outbursts. We used the measured flux density at the turnover frequency with the assumption of equipartition of energy between the particles and the magnetic field to infer the jet radius, the magnetic field, the minimum total energy and the transient jet power. The relatively low value of the jet power, despite V404 Cygni's high black hole spin parameter, suggests that the radio jet power does not correlate with the spin parameter. A paper on the results has been published in Astrophysical Journal [Nissim Kanekar, Poonam Chandra]

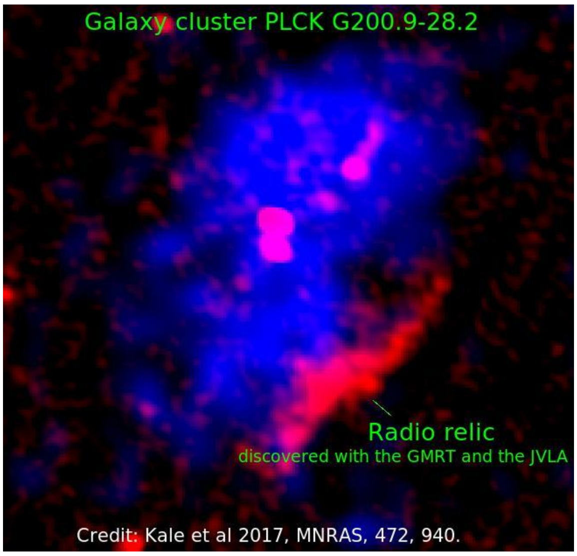
GMRT detection of the Galactic Warm Neutral Medium towards B0438-436

We have used the GMRT to carry out a deep search for Galactic HI 21cm absorption towards the quasar B0438-436, yielding the detection of wide, weak absorption, with a very low peak optical depth, ~ 0.001. Comparing this with the HI column density measured in the Parkes Galactic All-Sky Survey gives a column density-weighted harmonic mean spin temperature of 3760 +/- 365 K, one of the highest measured in the Milky Way. This is consistent with most of the HI along the sightline arising in the stable warm neutral medium (WNM). The low peak HI 21cm optical depth towards B0438-436 implies negligible self-absorption, allowing a multi-Gaussian joint decomposition of the HI 21cm absorption and emission spectra. This yields a gas kinetic temperature of <= 4910 +/- 1900 K, and a spin temperature of 1000 +/- 345 K for the gas that gives rise to the HI 21cm absorption. Our data are consistent with the HI 21cm absorption arising from either the stable WNM, with spin temperature much lower than the kinetic temperature, and little penetration of the background Lyman-alpha radiation field into the neutral hydrogen, or from the unstable neutral medium, with spin temperature approximately equal to the kinetic temperature. A paper on the results has now been accepted for publication as a Letter in Monthly Notices of the Royal Astronomical Society [Nissim Kanekar, Narendra Nath Patra, Jayaram Chengalur, Nirupam Roy]

Extra Galactic Astronomy and Cosmology

Discovery of a shock in a low mass galaxy cluster

Radio relics at the peripheries of high mass galaxy clusters are routinely used to trace shocks. However occurrence of such shocks in low mass clusters is unknown. We have discovered a radio relic that traces peripheral shock in a low-mass galaxy cluster PLCK G200.9-28.2 using the Giant Metrewave Radio Telescope and the Karl G. Jansky Very Large Array. This cluster is the lowest mass cluster known to have radio detected shock at its periphery. The relic has a projected size of ~1 × 0.28 Mpc, an arc-like morphology and is located at 0.9 Mpc from the X-ray brightness peak in the cluster. Under the assumption of diffusive shock acceleration, the radio spectral index implied Mach number of 3.3 ± 1.8 for the shock. Based on this cluster we have put forward the use of pressure and density offset to find signatures of shocks in low mass clusters [Ruta Kale, D.R.Wik, S. Giacintucci, T.Venturi, G.Brunetti, R.Cassano, D.Dallacasa, de Gasperin, F.]



The 235 MHz emission imaged with the GMRT is shown in red and the X-ray emission imaged with the XMM-Newton satellite observatory is shown in blue. The elongated source seen in red is the radio relic that traces a shock in the galaxy cluster PLCK G200.9-28.2.

An observation simulator to plan observing strategies with the GMRT, uGMRT and SKA

We have developed a radio observation simulator with the purpose of planning observing strategies tailored for searching diffuse extended radio sources. This was used to simulate observations of extended radio sources such as radio halos in galaxy clusters with the GMRT and the Upgraded GMRT. The recovery in flux density and in morphology of the model source was quantified in a variety of observing cases with changing source properties and the uv-coverage. We showed that the Upgraded GMRT will provide a factor of 2 better recovery of extended sources as compared to the GMRT for the same observing duration. Simulations of observations with the Square Kilometre Array were also carried out to show the effect of changing configurations on the capabilities of imaging extended sources. This simulator tool is made available upon request to the community [D.K. Deo, Ruta Kale]

Prospects for AGN feedback and cosmological studies using the Square Kilometre Array

The Square Kilometre Array (SKA) is the next generation radio telescope that is expected to reach unprecedented sensitivities. We have presented the science cases in the field of feedback from the active galactic nuclei (AGN) in galaxy clusters and cosmology using the SKA. The radio emission in brightest cluster galaxies coming from, both, AGN and star formation will be detectable for galaxy clusters up to redshifts of 1.4 allowing to study the role of the intra-cluster medium in triggering of AGN in the central galaxy [A. Ahangar, Ruta Kale, S.Majumdar, B.B.Nath, M.Pandge, P.Sharma, M.A.Malik, S.Raychaudhury]

ALMA mapping of CII 158-micron emission from a damped Lyman-alpha absorber at z=4.2

We have used the Atacama Large Millimeter/sub-millimeter Array (ALMA) to carry out high spatial resolution studies of ionized carbon CII 158-micron emission of a damped Lyman-alpha absorber at z=4.2. This has allowed us to measure the velocity field of a high-redshift, absorption-selected galaxy for the first time, demonstrating clearly that this is a massive rotating disk, similar to the Milky Way. We also find evidence for sub-structure in the velocity field, possibly indicative of merging clumps; around two-thirds of the CII 158-micron emission arises from the disk structure, and one-third from structures that are not in regular rotational motion. [Nissim Kanekar, M. Neeleman, J. X. Prochaska, C. L. Carilli, M. Rafelski]

ALMA detections of CO emission in high-redshift damped Lyman-alpha absorbers

We have used the Atacama Large Millimeter/sub-millimeter Array (ALMA) to detect CO emission from high-metallicity damped Lyman-alpha systems (DLAs) at z ~ 0.5-2.6, allowing us to measure the molecular gas masses of the absorbers. The inferred molecular gas masses are very large, 2-50 times larger than that of the Milky Way, and the impact parameters are also large, 15-40 kpc. The DLAs at intermediate redshifts, z=0.5-0.8, have very large gas fractions and low star formation efficiencies for their star formation rates and stellar masses, very unlike emission selected galaxies at similar redshifts and the local Universe. Their relatively low SFRs, despite the large molecular gas reservoirs, may indicate a transition in the nature of star formation at intermediate redshifts, after the peak epoch of galaxy assembly in the Universe. A paper on the results has been published in Astrophysical Journal Letters, and a second has been published in Monthly Notices of the Royal Astronomical Society. The two DLAs with CO detections at z~2.2 and z~2.6 have high molecular gas masses, and high star formation rates, similar to colour-selected star-forming disk galaxies at z~2. However, despite the strong CO emission indicating a large mass of cold gas, a Giant Metrewave Radio Telescope search for HI 21cm absorption from one of the DLAs yielded a non-detection of HI 21cm absorption, implying a high spin temperature. This emphasizes the multi-phase nature of the gas along the absorption sightline. A paper on these results has been published in Astrophysical Journal Letters, and a second paper has now been submitted to Monthly Notices of the Royal Astronomical Society. [Nissim Kanekar, J. X. Prochaska, M. Neeleman, M. Zwaan, P. Moller, L. Christensen Johan P. U. Fynbo]

ALMA detection of molecular absorption from a gravitational lens at z=0.765

We have used ALMA to detect redshifted CO and HCO+ absorption at z=0.765 from the spiral gravitational lens towards the quasar J0134-0931. This is only the fifth detection of molecular absorption at cosmological distances. The CO J=2-1 and HCO+ J=2-1 lines are seen along two different lines of sight to lensed images of the background quasar. The lines of sight are separated by ~0.7”, corresponding to 5 kpc in the lens plane. The absorption lines through the two sightlines have a velocity separation of 215 km/s, possibly representing rotational motion in the lens system. The absorption profiles are wide, 200 km/s between line peaks, suggesting that the absorption occurs in a highly inclined disk galaxy with a flat rotation curve and a cloud-cloud velocity dispersion of ~30 km/s. The CO and HCO+ column densities are normal for diffuse molecular clouds towards one of the lensed images, but significantly higher towards the other; it appear plausible that the second line of sight probes denser molecular gas than is normally the case for absorption in disk galaxies. A paper on the results has been submitted for publication to Astrophysical Journal [Nissim Kanekar, Tommy Wiklind Francoise Combes]

Simulated predictions for HI at z=3.35 with the Ooty Wide Field Array

Foreground removal is the most important step in detecting the large-scale redshifted H I 21-cm signal. Modelling foreground spectra is challenging and is further complicated by the chromatic response of the telescope. A multifrequency angular power spectrum (MAPS) estimator for use in a survey for redshifted H I 21-cm emission from z ~ 3.35 with the upcomming Ooty Wide Field Array (OWFA), was developed. We show via simulations that the MAPS estimator recovers the input angular power spectrum accurately and that the instrument response to the foregrounds dominates the systematic errors in the recovered foreground power spectra [V.R.Marthi, S.Chatterjee, Jayaram Chengalur, S.Bharadwaj]

Angular Momentum of Dwarf Galaxies

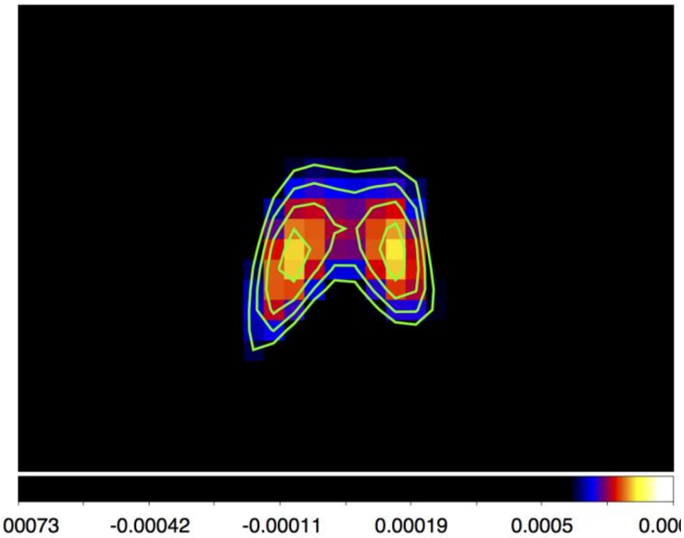
The specific baryonic angular momentum of five gas-rich dwarf galaxies was derived. The relation between the specific baryonic angular momentum (j) and the total baryonic mass (M) for these galaxies was compared with that found for spiral galaxies. The combined sample explores the j-M plane over three orders of magnitude in baryon mass. It is found that the dwarf galaxies have significantly higher specific angular momentum than expected from the relation found for spiral galaxies. It is suggested that this difference could arise due to one or more of the following: a lower baryon fraction in dwarf galaxies, particularly that arising from preferential outflows low angular momentum gas as found in high-resolution simulations that include baryonic feedback; 'cold mode' anisotropic accretion from cosmic filaments. This work reinforces the importance of the j-M plane in understanding the evolution of galaxies [Aditya Chowdhury, Jayaram Chengalur]

Stringent constraints on fundamental constant evolution from conjugate satellite OH lines

We have used the Arecibo Telescope to carry out one of the deepest-ever integrations in radio astronomy, targeting the redshifted conjugate satellite OH 18cm lines at z=0.247 towards PKS1413+135. The satellite OH 1720 MHz and 1612 MHz lines are respectively in emission and absorption, with exactly the same line shapes due to population inversion in the OH ground state levels. Since the 1720 and 1612 MHz line frequencies have different dependences on the fine structure constant and the proton-electron mass ratio, the perfect cancellation of the sum of the line optical depths makes them immune to systematic effects in probing putative changes in the fundamental constants with cosmological time. A non-parametric analysis of our new Arecibo data yields the most stringent present constraint on fractional changes in the fine structure constant from astronomical spectroscopy, and with no known systematic effects. A paper on the results has been published in Physical Review Letters. [Nissim Kanekar, Tapasi Ghosh Jayaram Chengalur]

A candidate sub-parsec binary black hole in the Seyfert galaxy NGC 7674

We discovered the nearest supermassive binary black hole candidate in the Seyfert galaxy NGC 7674 with the Very Long Baseline Array (VLBA). These results were published in Nature Astronomy [Preeti Kharb, D.V.Lal, D. Merritt]



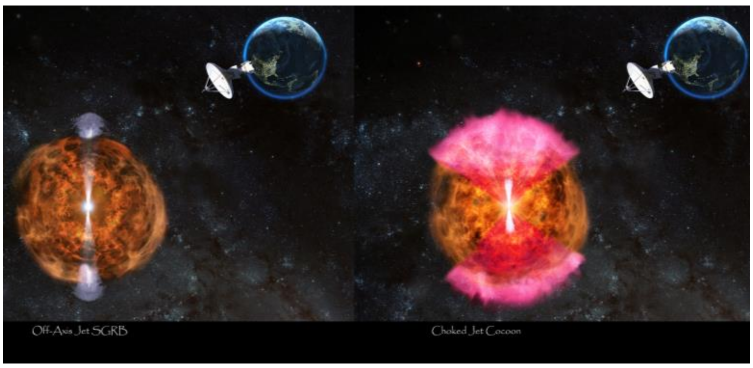
Two parsec-scale radio cores with inverted spectral indices are observed at 15 GHz with the VLBA in the centre of the Seyfert galaxy NGC 7674. At a projected separation of only 0.35 parsec, this is the closest supermassive black hole binary ever to be imaged

Estimating the magnetic field properties of disk galaxies from rotation measure synthesis.

Deriving the Faraday rotation measure (RM) of quasar absorption line systems, which are tracers of high-redshift galaxies intervening background quasars, is a powerful tool for probing magnetic fields in distant galaxies. Statistically comparing the RM distributions of two quasar samples, with and without absorption line systems, allows one to infer magnetic field properties of the intervening galaxy population. We have derived the analytical form of the probability distribution function (PDF) of the RM produced by a single galaxy with an axisymmetric large-scale magnetic field. We further determined the PDF of RM for a random sight line traversing each galaxy in a population with a large-scale magnetic field prescription. We find that the resulting PDF of RM is dominated by a Lorentzian with a width that is directly related to the mean axisymmetric large-scale field strength of the galaxy population, if the dispersion within the population is smaller than the mean. Provided that RMs produced by the intervening galaxies have been successfully isolated from other RM contributions along the line of sight, our simple model suggests that the mean large-scale field in galaxies probed by quasar absorption line systems can be measured within ~50% accuracy without additional constraints on the magneto-ionic medium properties of the galaxies. We also considered quasar sample selection criteria that are crucial to reliably interpret observational data, and argue that within the limitations of the current database of absorption line systems, high-metallicity damped Lyman-alpha absorbers are best suited to study galactic dynamo action in distant disc galaxies. A paper on the results has been published in Monthly Notices of the Royal Astronomical Society [Nissim Kanekar, A. Basu, S. A. Mao, A. Fletcher, A. Shukurov, V. Vacca, H. Junklewitz]

Radio emission from NS-NS merger

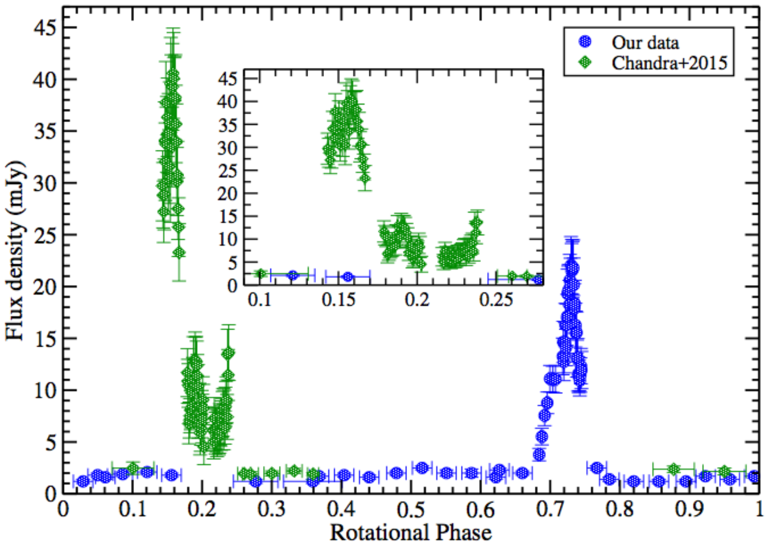
On August 17, 2017, the Advanced Laser Interferometer Gravitational Wave Observatory (Advanced LIGO), along with Advanced VIRGO data detected a gravitational wave event (GW170817) from the merger of two neutron stars (NS-NS merger) at a distance of 40 Mpc. Being the the NS-NS merger event discovered, it was followed by almost all known telescopes on the Earth and the space looking for electromagnetic (EM)



Radio observations of GW 170817 suggests a quasi-spherical, mildly relativistic outflow, consistent with the cocoon model signatures, including X-ray, ultra- violet, optical, infrared, and radio waves. We started following up the event with the Giant Metrewave Radio Telescope (GMRT). Even though the early radio observations at GMRT resulted in a non-detection, this provided constraints on the immediate environments, and hence GMRT played a key role in understanding jet physics and refining models of radio emission from the remnant formed by the merging neutron stars (Hallinan et al 2017). With our continued follow up, eventually we discovered the lowest frequency emission from the GW event at the GMRT 610 MHz frequency (Mooley et al. 2018, Nature). The GMRT observations, along with the Karl G. Jansky Very Large Array (VLA) and the Australian Telescope Compact Array (ATCA) suggested that the radio light curve of GW170817 was inconsistent with emission from a collimated jet viewed off-axis, instead requiring a quasi-spherical, mildly relativistic outflow, consistent with the cocoon model [Greg Hallinan, Kunal Mooley, Kishaley De ..... Poonam Chandra, ... Mansi Kasliwal]

Supernovae interacting with immediate environments

In a supernova explosion, much of a star's material (ejecta) is expelled with a velocity up to 30,000 km/s, driving a strong shock wave into the surrounding circumstellar medium (CSM). The shock interaction with the CSM gives rise to radio and X-ray emission. The radio emission is absorbed depending upon the properties of the surrounding medium and is most effectively traced at low radio frequencies as it varies with wavelength as λ^2. My graduate student A. J. Nayana is carrying out low frequency studies of core collapse supernovae with the GMRT towards her thesis. She observed more than a dozen core collapse supernovae and detected radio emission from 6 of them. She has modelled the long term follow up of SN 2004dj under this project. The data indicated inverse-Compton cooling at early times. Our observations have revealed that the SN exploded in a high density medium, and constrained the mass loss rate of the progenitor star [A. J. Nayana, Poonam Chandra]

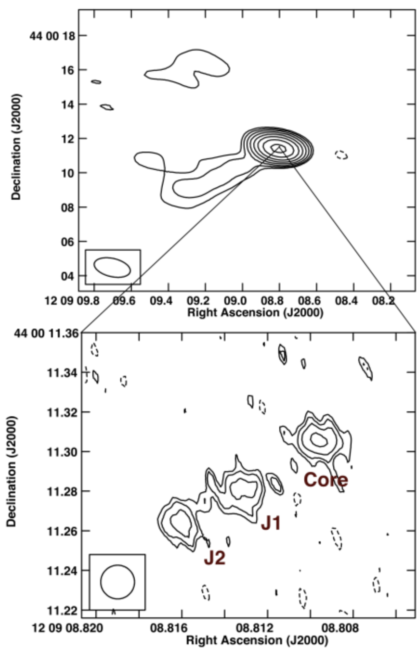


Gamma Ray Bursts: GRB 171205

While a typical GRB explosion lasts from milliseconds to a few minutes, the afterglow emission due to interaction of the jet with the surrounding medium can be seen for much longer. A major advantage of radio afterglow emission is that, due to slow evolution it peaks at much later time and lasts longer, for months or even years, presenting the possibility of following the full evolution of the fireball emission from the very beginning till the non-relativistic phase, when the geometry of collimation becomes insignificant and energetics can be determined more accurately. We are carrying out low frequency radio studies of the brightest GRBs with the GMRT. We have observed more than 15 GRBs at GMRT low frequencies under various GTAC and DDT proposals. We discovered radio emission from GRB 171205. More observations are being taken in the upcoming GMRT cycle [Poonam Chandra, Dipankar Bhattacharya, A. J. Nayana, S. Bradley Cenko, Alessandra Corsi]

Double-peaked Emission Lines Due to a Radio Outflow in KISSR 1219

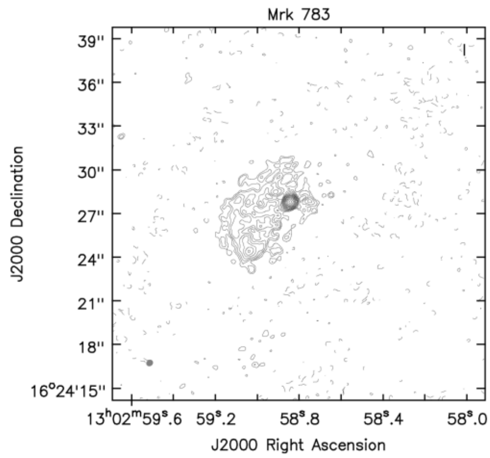
A small fraction of active galactic nuclei (AGN) exhibit splits in their emission line peaks; these are referred to as double-peaked emission-line AGN (DPAGN). DPAGN are potential candidates for binary AGN. We have been looking at several DPAGN with the VLBA which can detect radio emission on parsec-scales in these nearby AGN. Our study revealed the presence of one-sided core-jet structure in the DPAGN and Seyfert 2 galaxy KISSR 1219. A one-sided jet is also observed on kiloparsec-scales with the Very Large Array (VLA). Doppler boosting effects due to jet speeds of $\gtrsim$ 0.55c to $\gtrsim$0.25c, going from parsec to kiloparsec scales, and a jet inclination $\gtrsim$ 50^{O} can explain the jet one-sidedness in this source. A blue-shifted broad emission line component in [O III] was also indicative of an outflow in the emission line gas while the [O I] doublet lines suggested the presence of shock-heated gas. A detailed line ratio study using the MAPPINGS III code further suggested that a shock+precursor model could explain the line ionization data well. Overall our data suggested that the radio outflow in KISSR 1219 was pushing the emission line clouds, both ahead of the jet and in a lateral direction, giving rise to the double peak emission line spectra [Preeti Kharb, S. Subramanian, S. Vaddi, M. Das, Z. Paragi]



1.5 GHz VLA and (bottom) VLBA radio contour image of KISSR 1219 showing a one-sided core-jet structure, that could be a result of Doppler boosting effects in the observed jet luminosity

Radio-emitting narrow-line Seyfert 1 galaxies in the JVLA perspective

A radio survey of 74 narrow-line Seyfert 1 galaxies (NLS1s) was carried out with the Very Large Array (VLA) at 5 GHz. NLS1s are a special sub-class of AGN that resemble Seyfert galaxies in most respects but have narrower permitted lines in their



The VLA image of the narrow-line Seyfert 1 galaxy, Mrk 783, shows an interesting lobe structure with a steep spectrum, consistent with relic emission often observed in sources where the AGN has switched off

spectra compared to Seyferts. This survey is currently the largest survey aimed at imaging the radio continuum in NLS1s. We compared the radio properties of three different sub-samples: radio-quiet NLS1s (RQNLS1s), steep-spectrum radio-loud NLS1s (S-NLS1s), and flat-spectrum radio-loud NLS1s (F-NLS1s). We found that these sub-classes had different radio morphologies with F-NLS1s being more compact, and RQNLS1s showing diffuse emission on kpc scales. We concluded that F-NLS1s might be young blazars, and S-NLS1s may form a part of the parent population of F-NLS1s [M. Berton, E. Congiu, E. Jarvela, R. Antonucci, P. Kharb, M. Lister, A. Tarchi, A. Caccianiga, S. Chen, L. Foschini, A. Lahteenmaki, J. Richards, S. Ciroi1, V. Cracco, M. Frezzato, G. La Mura, P. Rafanelli]

Inhomogeneous Shock Structure crossing a dense shell in a supernova

We observed a Type Ib supernova (SN) Master OT J120451.50+265946.6 with the GMRT at multiple bands and multiple epochs. We modelled the radio observations with the synchrotron radiation emanating due to the SN ejecta interacting with the circumstellar medium created by a wind due to the mass loss from the progenitor star. The low frequency GMRT observations in the optically thick phase reveal inhomogeneities in the structure of the radio emitting region. The GMRT observations combined with the Karl G. Jansky Very Large Array data indicate that the inhomogeneous radio emitting shock is passing through a dense shell during the early epochs, around first 100 days. Our observations reveal the importance of obtaining well-sampled low-frequency data in order to understand the intricate nature of the radio emission from young supernovae. This work (Nayana et al.) has been submitted to ApJ [A. J. Nayana, Poonam Chandra, Claes-Ingvar Bjornsson, Peter Lundqvist, Francesco Taddia, Alak Ray]

Radio emission from Type Ia supernovae

We still lack knowledge about the origin of thermonuclear supernovae (SNe Ia), despite their huge cosmo-logical and galactochemical importance. There are two probable progenitor systems for SNe Ia. The first one, known as single degenerate (SD) channel, consists a single white dwarf (WD), which by accreting matter from a nondegenerate donar star explodes as a SN. The second channel, called double degenerate (DD), is composed of two spiraling WDs. One of the ways to discriminate the progenitor channels is to search for circumstellar material (CSM). The flux of radio emission from the SN shocks are roughly proportional to the density of the surrounding medium. Thus it is possible to trace the CSM through radio observations. We have started a project to explore radio emission from Type Ia SNe and in this GMRT cycle, we plan to obtain observations of four nearby type Ia SNe, SNe 1937C, 1885B, 1972E and 2014J, which are around 4 to 123 years of old. This work is in progress [Esha Kundu. Poonam Chandra, Peter Lundqvist, Miguel Perez-Torres]

Square Kilometre Array

NCRA leads Indian participation in the international SKA project :

The Square Kilometre Array (SKA) is the most ambitious international radio astronomy project attempted to date. It aims to build a telescope with 1 million square metres of collecting area, covering a large frequency range from about 50 MHz to 10 GHz, in a radio quiet region of the globe. This will result in an instrument that is at least 30 times more sensitive than the best today, capable of cutting edge science in several aspects of astronomy and astrophysics. As of today, eleven of the major radio astronomy practicing nations are collaborating in this project, which entered the design phase from November 2013 onwards, expected to last till middle of 2019. Construction of the telescope will then begin towards end of 2020, with early science expected by 2023-24.

India (represented by NCRA) is an active participant in the SKA since the early days, and became a Full Member of the SKA Organisation in October 2015. The SKA India Steering Committee, a high level committee set-up by the Department of Atomic Energy, provides guidance and monitoring of the overall SKA activities in India. The SKA India Consortium (SKAIC), created in February 2015, to bring together under one umbrella all organisations in India interested in SKA activities and coordinate the SKA related activities across the country, has increased its sphere of activities during this year. In addition to the main Executive Council of the SKAIC, two sub-committees of the SKAIC are also active : one to coordinate all the science related activities and another to coordinate all the technical activities.

Meanwhile, Indian involvement in the design phase activities of the SKA continued, with NCRA leading a collaboration of members from 7 different SKA member countries for the work on the design of the Telescope Manager – a sophisticated monitor & control system for the SKA, which will be like the brain and central nervous system of the observatory. The Telescope Manager consortium successfully completed several new milestones during this year, including the prequalification test for readiness to complete the Critical Design Review (CDR) and submission of the final set of design documents. The CDR meeting is scheduled for April 2018 with the timeline for closure of the TM design phase slated for June-July 2018. There was a major status update on the activities of the various consortia at the Annual SKA Engineering meeting in Rotterdam, The Netherlands in June 2017. NCRA also continues to be involved to a smaller extent in the Signal & Data Transport work package. Many of these SKA activities are being carried out in active collaboration with partners from Indian industry.

Alongwith the above, science activities related to the SKA continue to gain momentum in India. The SKA India Science Working Groups have been actively pursuing the development of the SKA India science case, as well as early activities related to theoretical and simulation studies, and pilot experiments with pathfinder and precursor facilities. Some of the highlights for this year are :

(i) following the publication of the SKA India science case in early 2017, the SKA India consortium organised a one-day SKA science workshop alongwith the annual meeting of the Astronomical Society of India in February 2018 in Hyderabad. Following this, work has started towards writing up the SKA India science case for the Detailed Project Report (DPR) to be prepared for submission to Government of India for approval of participation of India in the construction phase of SKA.

(ii) furthermore, various SKA-India SWGs have been exploring options to use existing facilities to prepare for SKA science. In this regard, some of the groups have already formed collaborations and applied for time in the GMRT. Updates and results from these activities are expected in the near future.

[Yashwant Gupta, T.R. Choudhury, Y. Wadadekar, N.M. Ramanujam, Jayaram Chengalur, S.K. Ghosh, J.P. Kodilkar, R. Uprade, S. Sherkar, NCRA-TIFR, India, working with partners from TRDDC, TCS, PSL and NVIDIA in India, and with colleagues from many other Indian institutions as well as from SKA members in South Africa, U.K., Australia, Canada, Italy and Portugal]

Instrument and Facilities

Infield Phasing of Phased Arrays

An experiment observations with a phased array witn "infield" phasing was conducted at the GMRT where the antennas were kept in phase throughout the observation by applying antenna based phase corrections derived from visibilities that were obtained in parallel with the phased array beam data, and which were flagged and calibrated in real time using a model for the continuum emission in the target field. It was shown that, as theoretically expected, the signal to noise ratio (SNR) does not degrade with time, in contrast to what is observed for traditional phasing. The degradation in SNR is well fit by a function of the form SNR(t) =a + b*exp(-(t/t0)$^{5/3}$), which corresponds to the case where the phase drifts are caused by Kolmogorov type turbulence in the ionosphere. [Sanjay Kudale, Jayaram Chengalur]

Upgrade of the GMRT Electronics Systems

The GMRT is undergoing a major upgrade which includes broad band seamless frequency coverage from 50 to 1500 MHz with improved sensitivity and maximum instantaneous bandwidth of 400 MHz. This is accompanied by other upgrades such as a next generation monitor & control system, a modern antenna servo system, improvements to the mechanical systems of the antennas, enhancements in data storage and computing resources, alongwith matching improvements in infrastructure facilities relating to civil and electrical systems. The upgrade requires several improvements to the front-end and back-end electronics systems of the telescope, including the fibre-optic system that connects these two systems. Many of these upgrade activities crossed important implementation milestones, leading to the third major release (in the last 3 years) of the upgraded GMRT systems to the user community. Many of these developments were presented by a team of engineers and astronomers from NCRA in the General Assembly of the URSI held in Montreal, Canada from 19 to 26 Aug 2017. Highlights of some these upgrade activities during this year are as follows :

1. Upgrades of the GMRT front-end and fibre-optic systems

1.1 GMRT front-end and fibre-optic systems :

The main changes being carried out to the front-end systems are the design and implementation of new, broadband feeds; matching RF front-end electronics systems with improved dynamic range; and associated improvements in the support electronics. For the fibre-optic system, there is a new scheme for transfer of broadband signals from each antenna to the central receiver room, while maintaining the availability of the existing system for transfer of narrow band signals with IF carriers.

1.1.1 For the GMRT feeds and front-end receivers, the following has been achieved

(a) The installation of the wideband feeds and matching front-end receivers was completed for all 30 antennas, for all the main 4 frequency bands of the upgraded GMRT : 130-260 MHz (Band-2), 250-500 MHz (Band-3), 550-850 MHz (Band-4) and 1000-1450 MHz (Band-5). This marked a major milestone completion for the upgraded GMRT. [Bhandari Hanumanth Rao, Ramesh S, Raut A.N., Bhalerao V. B., Prajapati A., Khan I., Kumbhar G.C., Temkar V., Chaterjee S., Parikh G.P., Vawhal A, Sureshkumar S.]

(b) An upgraded high dynamic range version of the common box electronics that comes after the front-end systems has been installed on the first 5 antennas. It has a much better dynamic range (1 dB compression and IP3 points) and is better in handling broadband signals without saturation, and also hosts the new monitor and control card that is part of the final system. [Temkar Vishal B., Kumbhar Ganesh C.]

(c) As part of the attempt to keep improving the electronics for the upgraded GMRT, a new 3-stage Low Noise Amplifier (LNA) has been designed to provide a better design for the Band-5 (1000-1450 MHz) receiver of the GMRT. The prototype unit built has achieved a noise temperature of 20 degrees Kelvin, gain of 45 dB and input matching better than -10 dB over the entire band. It has been successfully installed on 2 antennas and is under detailed testing and characterisation before being taken up for mass production [Raut A.N., Chatterjee, S.]

1.1.2 Highlights from the Signal Transport and Fiber-Optics Systems are as follows

Having completed the main task of delivering a reliably working RF over fibre system to bring back the wideband signals of the upgraded GMRT from all of the 30 antennas to the central receiver building, more than a year ago, the team has turned it’s attention to other challenges. The prototype version of the ethernet optical fibre link that will allow control of the front-end electronics at the focus of the antenna, from the base of the antenna, was designed and tried out. This requires special RFI shielding of the equipment, and improvements in this are presently underway [Sureshkumar S., Raybole Pravin, Lokhande Satish, Rai Sanjeet]

2. Upgrades of the GMRT back-end systems

2.1 GMRT back-end systems :

As part of the GMRT upgrade, new back-end systems are being implemented to achieve the specifications for the upgrade like increased bandwidth of 400 MHz, direct processing of RF signals, increased dynamic range, improved channel resolution in the digital back-ends etc. A significant feature of the new system is the reduction in electronics at the remote antenna sites and shifting of most of the complex signal processing operations to the Central Electronics Building (CEB) which will reduce the down time of antennas in case of problems. Some of the main developments in this year have been as follows.

2.1.1 Analog Back-end System

The full Analog Backend system for all 30 antennas improved dynamic range, facility for variable gain, selectable signal bandwidth and individual LO signal for each antenna, has been completed and released for use, and is functioning well for more than 2 years now. Work on further improvements in the LO system was initiated during this year, which will provide a highly flexible configuration to provide independently settable LO signals for each polarisation of each antenna, alongwith the capability of phase memory when the LO frequency is switched back and forth between two different values. The prototype version of this new design was tested and will soon be entering mass production for all the 30 antennas. [Ajithkumar B., Shinde Navnath, Gupta Sweta , Nanaware D.K., Ganla Atul, Dhende Abhijeet, Phakatkar Sudhir, Hande P.J., Vishwakarma Ajay]

2.1.2 Digital Back-end Systems

The full 30-antenna digital back-end system which implements a GPU-based hybrid correlator and beamformer (with incoherent and coherent modes and a pulsar preprocessor) was completed more than a year ago. Further refinements that were carried out in the system during this year were : a real-time coherent dedispersion for the beamformer was completed and released; improvements in the spectral zoom mode were carried out; prototype set-up for buffering the user from the main system to preserve the real-time performance of the back-end, was completed and will be released shortly for regular use; improvements in the graphical user interface available to the operator were also carried out.

Work was also initiated on the implementation of a parallel system which will get a copy of the digitised data from all the 30 antennas and will carry out specialised signal processing tasks that will enhance the performance capabilities of the GMRT. [S. Harshvardhan. Reddy, Sanjay Kudale, G.J.

Shelton, Nilesh Raskar, I.M. Halagalli, I.S. Bhonde, B. Ajithkumar, Yashwant Gupta]

Work was continued on the scheme for the implementation of Walsh demodulation in the back-end receiver. The prototype had been tested last year and shown to achieve 99.5% rejection of unwanted leakage signals in the antenna signal path. Work was done this year to start the implementation of this scheme in the main system and make its performance more robust. [Sandeep C Choudhari, Navnath Shinde, Sweta Gupta, B Ajithkumar, Yashwant Gupta]

Further progress was made on the trials for a scheme for digitisation of signals at the antenna. This is a project being implemented in co-ordination with Optical Fiber group and involves digitising the RF signals at remote sites and transporting the digital data through OF cables to central station for combining and processing. More detailed studies were carried out using the prototypes which have been developed and installed at few antennas to study the performance of the system in comparison with the existing uGMRT receiver. [Sandeep C Choudhari, Navnath Shinde, Sweta Gupta, B Ajithkumar, Yashwant Gupta]

3. Radio Frequency Interference protection for the GMRT

One of the major challenges for the upgraded GMRT is to contain the problems posed by Radio Frequency Interference (RFI) from various sources of electromagnetic signals from man made activities in and around the GMRT array. This includes identifying and mitigating the sources of RFI at their source, to finding techniques for avoiding or reducing the influence of RFI in the receiver chain, and finally to excising RFI at various stages of the receiver system. The activity spans work carried out by different groups at GMRT. Some of the main achievements during the last year are as follows :

3.1 RFI mitigation at source

The wideband operation of the upgraded GMRT significantly increases the risk of RFI from external and internal sources like commercial transmission (mobile, TV, FM radio), modern computers and network equipment and high voltage electrical lines. The RFI team continues to carry out extensive survey to identify sources of RFI and work out possible solutions. Some of the highlights for this last year as follows : a detailed characterisation of RFI from electrical transmission lines and equipment in the GMRT neighbourhood was carried out and items needing corrective attention were identified; work was done for designing and building RFI shielding enclosures for equipment at the observatory such as air-conditioning units, LED lamps, UPS units etc, and good success was achieved in many cases; detailed characterisation and follow-up of RFI from leakage of signals from cable TV systems in nearby towns was done. [P Raybole, S. Sureshkumar, Sanjeet Rai, Ankur Prajapati]

3.2. RFI excision in the back-end receiver

Different schemes for detection and filtering of RFI signals in the digital back-ends of the upgraded GMRT, based on statistical properties of the desired signal and RFI, are being developed. During this year, further tests and characterisation were carried out with the first version of the scheme that works in real-time on the digitised voltage signals from each antenna. Some improvements in this scheme, including moving to the integrated intensity domain, were also developed and are being tested. In addition, development of the filtering algorithm in the frequency domain was also initiated. Finally, further refinements were carried out to the filtering scheme that had been developed for the beamformer data, working in the time-frequency domain, and improved performance was demonstrated and made available to the user. [Kaushal D Buch, Kishore Naik, Swapnil Nalawade, B Ajithkumar, Aditya Chowdhury, Ruta Kale, Yashwant Gupta]

4. New Monitor & Control System for the upgraded GMRT

To control and coordinate the upgraded GMRT systems for performing astronomical observations, efforts are on to develop a next generation Monitor and Control (M&C) system. This includes modern hardware and software architectural features compared to the existing GMRT control system, including futuristic developments that could be of relevance to next generation radio telescopes such as the SKA. Some of the highlights are as follows. [Jitendra Kodilkar, Raj Uprade, Charudatta Kanade, Rahul Bhor, Mahadev Misal, C. Sateesh, B. Rajendran, Santaji Katore, Deepak Bhong, Sachin Sherkar, S. Nayak, Yashwant Gupta]

4.1. New M&C modules

New Monitor and Control Modules (MCM) developed based on Rabbit RCM 4300 micro-controller, completed mass production and had significant software and firmware developments to implement control of various GMRT sub-systems at antenna base and in the Central building. Installation and testing of these MCM cards was completed for the Sentinel, Optical Fiber and FPS sub-systems at antenna base. For simultaneously updating the firmware on multiple MCM cards over the Ethernet interface, a Remote Firmware Update application has been developed and tested. To update the firmware, a web-interface is provided. The application will be used to update/maintain the firmware running on rabbit MCMs for all 30 antennas

4.2. Next Generation M&C Software System

NCRA is actively involved in the development of a next generation M&C system applicable for large systems (including radio telescopes like the GMRT and the SKA), in collaboration with the TRDDC research laboratory and partners from software industry. As a first step of this effort, a modern M&C system software is being developed for the GMRT, which can be used as a demonstrator for SKA and can help evaluate and test various kind of prototypes required in the SKA design. The development of Phase-2 of this system was completed, and Phase-3 is now well under way, wherein new features and capabilities are being added to the software, in addition to the basic capabilities that were implemented in Phase-1 and Phase-2. Also, the configuration is being expanded to cover more number of antennas. The design and growth are being in a manner that is in parallel with the existing M&C system. The software architecture of the new M&C system is based on the TANGO open source software framework, and supports features like data driven configuration, scalability, and facility to evolve. The software architecture of the new M&C system is thus more aligned with the requirements of the Telescope Manager functionality planned in SKA1, and is expected to have direct relevance and feedback into this SKA design work, that is led by India. The GMRT M&C system development work is being carried out by the GMRT Operations Group, in close collaboration with industry partners TCS Pune.

5. GMRT Servo system Upgrades.

After completing all the major planned upgrades five months ahead of planned schedule, a new project to improve the operation of feed position systems (FPS) has been initiated. A new design of FPS was undertaken and tested in laboratory and on a mock feed turret. Last year, the main focus was antenna trials for validation of the design and repeatability tests with an aim to freeze the current design for mass production and commissioning. Following validation on C10 antenna, another system was installed on C04 antenna in January this year. Both these systems are being tested during regular operations. The current design is being improved based on field performance and it is planned to initially commission 5 more antennas next year [Suresh Sabhapathy, Shailendra Bagade, Amit Kumar, B. Thiygaraj, T Haokip, Sandeep Malu, Abhay Bhumkar and Bhal Chandra Joshi]

6. Release of the third phase of the upgraded GMRT

The good progress achieved in the upgrade activities described above resulted in the third phase of the upgraded GMRT (uGMRT) being released to the user community. For the GMRT Observing Cycle 32, starting from April 2017, a 30 antenna uGMRT system supporting wideband observations of upto 400 MHz bandwidth with 2 bands fully functional (Band-5 : 1000 to 1450 MHz and Band-3 : 250-500 MHz) was released for users. For Cycle 33, which started in October 2017, 2 other bands of the uGMRT – Band-2 : 120-240 MHz and

Band-4 : 550-850 MHz – were released for use for the first time, though with less than the full complement of 30 antennas. There has been a growing preference of users to start using the uGMRT systems over the legacy systems, with the ratio of proposals for the uGMRT overtaking those for the legacy system during this year.

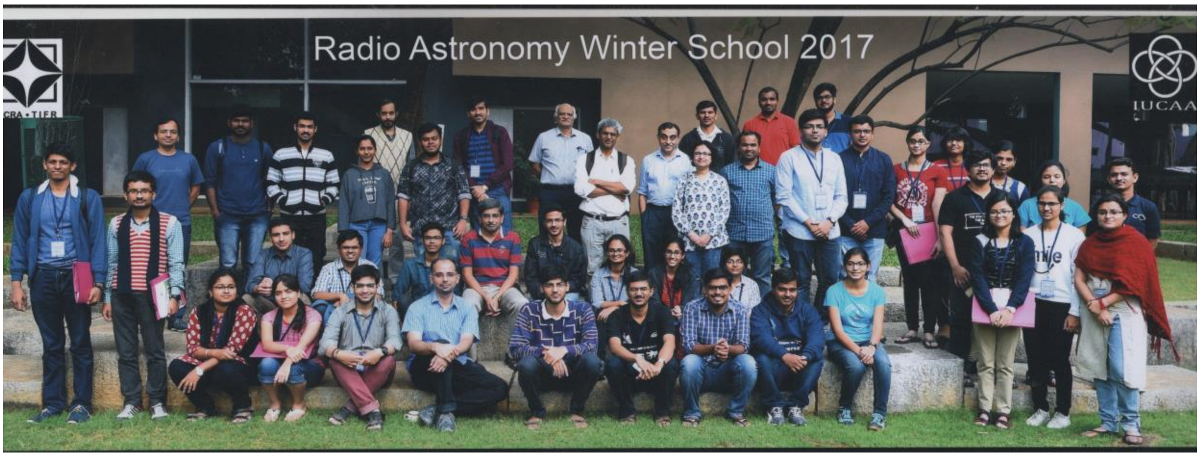
Radio Physics Laboratory

Radio Physics laboratory (RPL) is a joint collaborative initiative between NCRA-TIFR and IUCAA. Its main goal is to provide a platform for training under-graduate students in science and engineering in radio astronomy techniques and instrumentation. Like the previous years, RPL organised Radio Astronomy Winter School for College students (RAWSC) from 18th to 26th of December 2017. Thirty college students (mostly in their second or third year of Graduation) selected from across India participated in this school.

A total of 10 lectures encompassing different topics of Astronomy & Astrophysics were arranged for them. They also carried out radio astronomy (e.g., radio emission from Sun, detection of HI from our Galaxy using the 3m RPL antenna) and laboratory expriments on physics and electronics (e.g., Noise temperature of resistors, Superheterodyne radio receiver). A visit to GMRT observatory was also arranged as part of this programme.

RPL facilities were also used for a two months project (May-June 2018) of an Integrated PhD student to study variation of line of sight velocity of Galactic HI at different Galactic longitudes.

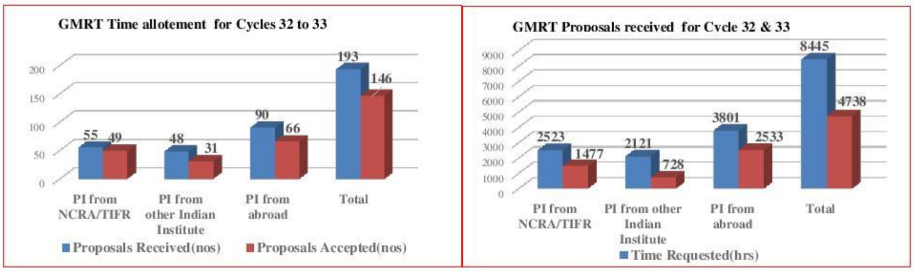
Other than the above, RPL also demonstrated experiments to detect Sun and Galactic HI to about 30 Indian Academy of Science summer students on 5-6 July 2018.



GMRT Proposals and Time Allocation

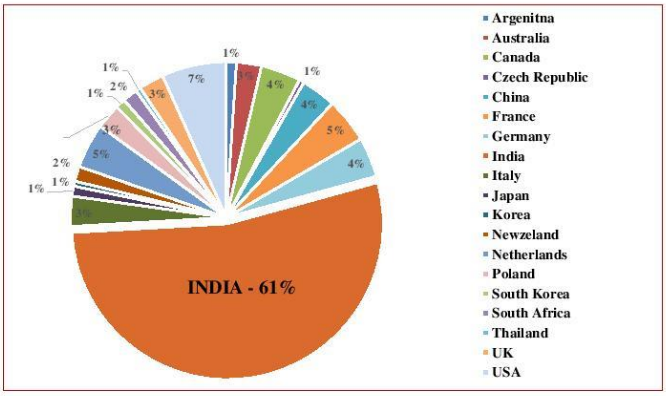
GMRT observing Cycle 32 ran from 20 April 2017 to 27 September 2017 and Cycle 33 ran from 20 October 2017 to 26 March 2018, with the gap in between being the maintenance break, for upkeep and improvement activities. A total of 102 and 91 proposals were received, of which 73 and 70 proposals were allocated observing time in cycles 32 and 33, respectively. A total of 4667 hrs and 3777 hrs were requested and 1871 hrs and 1866 hrs were allocated for these two observing cycles, giving an over subscription rate of 2.5 and 2.0, respectively. In cycle 32, there were a total of 29 proposals (for 771 hrs) and 44 proposals (for 1120 hrs) requesting for the legacy GMRT system and for the upgraded GMRT system, repectively. For cycle 33, these numbers were 21 proposals (for 558 hrs) and 49 proposals (for 1204 hrs) respectively. This reflects the growing popularity and demand for the upgraded GMRT. In Cycle 32, the usage of frequency bands was : Band-5 / 21 cm -- 45%, Band-4 / 50 cm -- 18%, Band-3 / 90 cm -- 34% and Band-2 / 200 cm -- 3%. For cycle 33, the corresponding numbers were somewhat similar : Band-5 / 21 cm -- 41%, Band-4 / 50 cm -- 23%, Band-3 / 90 cm -- 35% and Band-2 / 200 cm -- 1%.

GMRT Proposal statistics - Cycle 32 & 33



Cycle 32 & 33 Countrywise Distribution of Proposal submitted status

Country	Nos
Argenitna	2
Australia	5
Canada	8
Czech Republic	1
China	7
France	9
Germany	8
India	103
Italy	6
Japan	2
Korea	1
Newzeland	3
Netherlands	9
Poland	5
South Korea	2
South Africa	3
Thailand	1
UK	5
USA	13



Staff List

Pune

Academic

Bhattacharyya B., Chandra P, Chengalur J. N., Gupta Y, Ishwara Chandra C H, Joshi B. C., Kale R.P., Kanekar N., Kantharia N. G., Kharb P., Lal D.V., Mitra D., Oberoi D, Roy Choudhury T, Roy J., Roy S, Visweshwar Ram M.R., Wadadekar Y.G., Ghosh S. K., Saikia D. J., Sirothia S. K.,

Research Scholars

Atul Mohan, Baghel Janhavi, Bait Omkar S., Basu Avishek K., Bera Apurba, Bera Prasanta, Biplab Bijay, Biswas Ayan, Chakraborty Soumyadeep, Chatterjee Atrideb, Choudhuri Samir, Chowdhury Aditya, Das Barnali, Dutta Uttaran, Jain Divesh, Joshi Deepak C., Joshi Deepak C., Kansabanik Devojyoti, Kaur Balpreet, Kurapati Sushma, Maity Barun, Malik Ritika.

Post-Doctoral Fellows

Hariharan Krishnan, Konar S, Lijo Thomas G., Patra Narendra N., Sonkamble Satish S., Vaddi Sravani, Gaikwad Prakash S., Kale R., Kamphuis Peter, Khaire Vikram K, Mondal Rajesh, Prasad A.

Scientific

Bollapragada N.R., Girpunje J.D., Hendre A.S., Roy Jayashree, Kate G. J., Meghe AA, Roy Jayashree, Ramanujam N M, Shelat D. S., Singh A.,

Technical

Bhilare P. D., Gardasu B., Gole S.R., Jadhav P. D, Kamble V. S., Karekar P. G., Meshram S.G., Mhetre G.V., Murugesan S., Patil T. M., Shelar P. B., Sutar G.N., Venkatasubramani V., Hande S.S., Lomate Y.M., Patil R.R., Thorat H.D., Sahoo D.

Administration

Adhikari S.S., Barve A. P., Bhujbal J. A., Ganeshan G., Gonde N.B., Jayasimha B. R., Joshi A., Khatavkar H. C., Khatkale S. J., Kulkarni M. M., Kulkarni S. M., Lokhande H. D., Mandhare J. D., Pandiselvan C., Patil S. V., Pawar D. V., Pawar K. R., Reena Shrikumar, Sabne M. M., Sangle B. S., Solanki J. K., Sonsale S.M., Verma V.K., Shetty S, Kuriakose, S.I., Mule S.G., Pendse S.S., Shinde R.S., Shinde S.A., Bhalgat S. R., Gawas S.T, Girnar G. A., Lakhe P. S., Ovhal N.S., Patil B.N., Sant R. S., Sharma S, Shinde K.M.,

Auxiliary

Bahirat R. E., Dalvi F. M., Gaikwad V. V., Khole N. B., Langhi S.J., Nalawade B. T., Nalawade G. A., Pawar V. R., Shelar K. S., Sodanavar V. R., Singh H,

Khodad

Scientific

Ajith Kumar B., Amit Kumar, Ankur, Bagde S. K., Buch K.D., Chatterjee S, Chaudhari S C, Gnanaraj S.J., Gupta S, Hanumanth B R, Joardar S., Kale H. S., Khan I, Muley M.V., Nandi A.K., Nayak S., Parikh G.B., Patil M.S., Rai S.K., Raut A. N., Reddy H.S., Sabhapathy S, Shinde N. D., Suresh Kumar S., Swami R. V., Thiyagarajan B., Uprade R.R., Shaikh Amer K.M., Gadekar S S, Ghalame A.B., Hendre.A.S, Malu S.K., Naik K.D., Naik N.V., Nalawade S. S., Saurabh S.

Technical

Bachal Shailendra J, Bhalerao V. B., Bhonde I. S., Bhong D.B., Bhumkar A.K, Bomble R. R., Burle S. M., Dhende A. T., Diwane A.A., Dongare S.N., Dubal S.S., Gaikwad K. R., Gaikwad P. S., Gaikwad Y.S., Ganla A.A., Gavit S.Z., Ghangale J. L., Ghorpade D.D., Goril S.K., Halagali I, Hande P. J., Haokip T. S., Kamble J. R., Kamble U. S., Kanade C. P., Kasar P. N., Katore S. N., Kedari H.V., Khande D.R., Kodilkar J. P., Kotawadekar A.P., Kudale S. S., Kumbhar G.C., Lokhande S. K., Lolap R.K., Mirajkar S.S., Misal M.B., Nalawade J. R., Nanaware D. K., Padwal P.T., Patil B. S., Patil S. D., Phakatkar S. V., Poonattu A. M., Rajendran B., Ramesh S., Raskar N.S., Raybole P. A., Sakthivel A., Samble M.S., Sherkar S S, Shinde N.J, Shirsath S.E., Somwanshi M. D., Talpade K. M., Temgire D. D., Temkar V.B., Thorat G M, Thorat G. G., Thorat R.B., Umbarje M. S., Vasave R. J., Vawhal A.A, Vishwakarma A.M., Walunj D. V.

Administration

Deshmukh N. S., Joglekar A.C., Jondhale A. B., Kanade D S, Kharmale V.S., Naik R. Y., Rohini Rajshekhar, Shaikh I G K, Devpuje R.R., Jadhav V.P., Thorat Dnyaneshwar B., Badhe A. B., Bora T.S., Gaykar S. B., Mohite P. S.

Auxiliary

Bhalshankar S. L., Bhor A. G., Chaskar B.D., Dambale D. S., Dhumal P.T., Gaikwad B. S., Gawade S.N., Ghangale S. J., Ghorpade C. H., Ghorpade D. B., Gundgal D. K., Karkud R. B., Kuchik S. M., Mule N. D., Pingale R. Y., Sable B. C., Shelake J. C., Thorat D. B., Vighe V.E., Yamgar L.B., *(Auxiliary – Technical)* Aher V. K., Bhor S. G., Hande N. V., Wajge B. T., Gadhave R.B, Gaikwad S. R., Ghangale H. K., Kotwal A. R., Shigwan R. B., Thorat K. T.,

Ooty

Academic

Manoharan P. K., Krishnakumar M.A., Prabhu D.S., Subramanian Prasanna, Surnis Mayuresh Prakash,

Scientific

Rajamohan S., Mittal Amit Kumar, Kavitha K., Uma Maheswari C,

Technical

Alagupandiyaraja M, Chandrasekaran R., Jadhav N. B., Kalyanasundaram K., Nallasivam M., Praveen P., Raja K., Ravikumar D., Rodrigues I. E., Senthil Kumar S.J., Sivakumar. S, Venkatasubramani R., Chandrasekharan V.,

Administration

Ghatal U.D., Lali Shantha Kumari N, Packiaraj V., Sruthi R., Vanitha R., Brito Ruban A., Sakthivel G., (*Auxiliary*) Chandrakala V, Karpagam M, Mahendran R., Ravi Sankar R., Sarak D. P., (*Auxiliary - Technical*) Aiyyappan S, Sankaran M., Thangakumar A,

National and International Involvement

Bhattacharyya, Bhaswati

Member

1. Marie Curie Alumni Association since 2015.
2. Square Kilometre Array (SKA) pulsar science working group since 2015.

Chengalur, Jayaram

Member

1. National Committee of the IAU
2. SKA Science Working Group
3. Journal of Astronomy and Astrophysics editorial board
4. Sectional Committee of the Indian Academy of Science.
5. Chair Scientific Organizing Committee, Astronomical Society of India

Gupta, Yashwant

1. *Science Director* from India on the Board of the international Square Kilometre Array Organisation
2. *Leader* of the Telescope Manager Consortium -- an international collaboration for work on the design of the Telescope Manager system for the SKA, led by NCRA.

Chair

3. TMT-India Software Work Packages Monitoring Committee that oversees the overall development of software packages in India, for the Thirty Metre Telescope International Project
4. Astronomy and Computational Physics sub-group of the Applications Group of the National Supercomputing Mission.

Member

5. Governing Council of the Indian Institute of Astrophysics (IIA), Bengaluru.
6. BRICS Astronomy Working Group.

Joshi, Bhal Chandra

Member

1. Panel on Education, COSPAR
2. RadioAstron International Science Committee
3. GMRT Time Allocation Committee

Kharb, Preeti

1. *Member* Scientific Organising Committee (SOC) international conference on Revisiting narrow-line Seyfert 1 galaxies and their place in the Universe, Padova, Italy from 9-13 April 2018.
2. *Reviewer* NASA' s Chandra X-ray Observatory Cycle 19 Peer Review Panel, June 20-21, 2017
3. *Reviewer* , Grant proposal for the National Science Centre, Narodowe Centrum Nauki, NCN, panel ST9, Govt. of Poland
4. *Referee* , 5- international peer-reviewed journal articles ApJ [2], MNRAS [1], JoAA [2])

Kanekar, Nissim

Member

1 Science Working Group ``Time Domain, Cosmology, and Physics for the Very Large Array - 2020.

2 Scientific Organizing Committees for the conference PHISCC-2018, to be held in Pingtang, China, in June 2018.

3 Time Allocation Committee for the Devasthal 3.6m Optical Telescope, of the Aryabhatta Research Institute for Observational Sciences.

Referee

1 Astrophysical Journal and Astronomy and Astrophysics, and for proposals for observing time on the Giant Metrewave Radio Telescope.

Kale, Ruta

Member, Astronomical Society of India

Lal, Dharam Vir

1 *Core Member* SKA: Extragalactic Continuum (galaxies/AGN, galaxy clusters)

2 *Co-chair Member,* SKA-India: Continuum Survey

Manoharan, P.K.

Editor

1. Geosciences Letters, Asia Oceania Geosciences Society (AOGS).
2. Journal of Space Weather and Space Climate
3. Indian Journal of Radio Science
4. National Coordinator, International Space Weather Initiatives (ISWI) Programme in India.

Member

1. Axford Medal Nomination Committee, Asia Oceania Geosciences Society (AOGS)
2. Astronomical Society of India (ASI)
3. Asia Oceania Geosciences Society (AOGS)
4. International Astronomical Union (IAU)
5. Community of European Solar Radio Astronomers (CESRA)
6. Scientific Organizing Committee of the IAU Symposium IAUS 340, Long-Term Datasets for the Understanding of Solar and Stellar Magnetic Cycles, February 19-24, 2018.
7. *Co-PI*, Aditya-L1 Space Solar Coronagraph Project, ISRO, India

Oberoi, Divya

1. *Co-chair,* Solar, Heliospheric and Ionospheric Science International Science Working Group of the Square Kilometre Project.
2. *Vice-Chair*, Solar, Heliospheric and Ionospheric Science consortium of the Murchison Widefield Array project
3. *Member*, Executive Council of Astronomical Society of India

Visits

Bhattacharyya, Bhaswati

1. New York University Abu Dhabi , March 2017
2. Jodrell Bank, Manchester, UK. September 4−8, 2017
3. University of Manchester, Manchester UK, September 11−15, 2017
4. Bologna, Italy 19−23 June 2017, Bologna, Italy

Bhandari, Hanumanth Rao

1. 32nd General Assembly of URSI, Montreal, Canada , August 19-26, 2017

Chowdhury A.

1. 32nd General Assembly of URSI, Montreal, Canada, August 19-26, 2017

Chaudhari, S.

1. 32nd General Assembly of URSI, Montreal, Canada, August 19-26, 2017

Gupta, Yashwant

1. Rotterdam, The Netherlands, June 12-17, 2017
2. 32nd General Assembly of URSI, Montreal, Canada , August 19-26, 2017
3. Indian Institute of Astrophysics, Bangalore , September 24-25, 2017
4. Bonn, Germany, and Bologna, Italy, November 7-9, 2017
5. Sydney, Australia, December 12-15, 2017
6. BITS Hyderabad, January 6-8, 2018
7. ASI Hyderabad, India, February 5-9, 2018
8. Kolkata, India, March 6, 2018
9. Manchester, UK, March 7-9, 2018

Joshi, Bhal Chandra

1. Tata Institute of Fundamental Research, Mumbai, April 28, 2017
2. Inter-University Center for Astronomy and Astrophysics, Pune, May 15-16, 2017
3. Indian Institute of Technology, Guwahati, May 18-20, 2017
4. Jodrell Bank Observatory, Lower Withington, Macclesfield, Cheshire, United Kingdom, September 4 - 8, 2017
5. BITS-Pilani, Hyderabad Campus, Hyderabad, January 3-8, 2018
6. Osmania University, Hyderabad, India, February 5 - 9, 2018
7. Saha Institute of Nuclear Physics, Kolkata, March 6 - 9, 2018.

Katore, S.

1. 32nd General Assembly of URSI, Montreal, Canada, August 19-26, 2017

Kharab, Preeti

1. Centre for Astrophysics (CfA), Cambridge MA, USA, 22 - 27 June 2017
2. The Netherlands Institute for Radio Astronomy, ASTRON, March 24 -April 9, 2018

Kanekar, Nissim

1. Columbia University, New York, USA; April 2018
2. National Radio Astronomy Observatory, Socorro, New Mexico, USA; April 2018
3. University of California, Santa Cruz, U.S.A.; March 2018
4. Ashoka University, Haryana; March 2018
5. National Institute of Science Education and Research, Bhubaneswar; March 2018
6. Presidency University, Kolkata; October 2017
7. University of California, Santa Cruz, U.S.A.; July 2017
8. Physical Research Laboratory, Ahmedabad; June 2017

Kale, Ruta

1. Physics of the ICM, Beijing, China, April 3-7, 2017
2. University of Montreal, Montreal, Canada, August 17- 28, 2017
3. Raman Research Institute, Bangalore, India, October 1 – 7, 2017
4. ASI Meeting, Hyderabad, India, February 5 – 9, 2018
5. Salt Lake City, USA., March 18 – 28, 2018

Manoharan, P.K.

1. Harvard-Smithsonian Center for Astrophysics, University Harvard, Cambridge MA, USA, August 7,2017
2. MIT Haystack Observatory, USA, August 8,2017
3. Space Weather Laboratory, NASA Goddard Space Flight Center, Greenbelt, Maryland, USA, October 1–30, 2017

Nayak, S.

1. 32nd General Assembly of URSI, Montreal, Canada, August 19-26, 2017

Oberoi, Divya

1. MIT Haystack Observatory, 27th July to 1st August, 2017

Raut, Anil

1. 32nd General Assembly of URSI, Montreal, Canada, August 19-26, 2017

Raybole, P.

1. 32nd General Assembly of URSI, Montreal, Canada, August 19-26, 2017

Reddy, Harshvardhan S.

1. 32nd General Assembly of URSI, Montreal, Canada, August 19-26, 2017

Awards and Distinctions

Chandra, Poonam

Guest Professor, Depart of Astronomy, Stockholm University for a period of 20th Aug 2017 till 31 May 2018.

Kale, Ruta

Young Scientist Award by the International Union of Radio Sciences (URSI), 2017

Kanekar, Nissim

The Shanti Swarup Bhatnagar award of the Council of Scientific and Industrial Research for the year 2017, September 2017

Invited Talks in Conferences and Meetings

Bhattacharyya, Bhaswati

1. Broad Impact of Low-frequency radio astronomy, Pulsars and transients with the GMRT, INAF - Istituto di Radioastronomia, Via Gobetti, Bologna (Italy), June 19−22, 2017.
2. Searching for pulsars with the GMRT, Science with a UAE DSN antenna, New York University Abu Dhabi, March 25, 2018.

Chandra, Poonam

1. Exploring core-collapse supernovae at radio frequencies, Oskar Klein Centre Colloquium, , Stockholm University, Jan 31, 2018
2. RETCO-III, IIST Thiruananthpuram, June 4-6, 2017
3. Panelist on Multi-messenger Astronomy with GWs in LIGO-India: The road ahead, IUCAA, May 15 - 16, 2017

Chengalur, Jayaram

1. Radio Astronomy & the GMRT, Young Astronomers Meet, IUCAA, May 26, 2017

Gupta, Y.

1. Gamma-ray Bursts : Prompt to Afterglow, The Upgraded GMRT : Current Status & Future Plans, GMRT, Khodad, on July 6, 2017
2. URSI General Assembly, The GMRT : a look at the Past, Present and Future, Montreal, Canada, August 25, 2017
3. BRICS Astronomy Workshop on Infrastructure and Instrumentation, Radio Astronomy at NCRA, Pune, India, September 22, 2017
4. The Third National Symposium on Particles, Detectors, and Instrumentation, Detection of Radio Waves from the Universe : Current Status & Future Prospects, TIFR, Mumbai, October 5, 2017
5. Science at Low Frequencies IV, The uGMRT : Opening new windows to the Low frequency radio Universe, Sydney, Australia, December 13, 2017
6. Neutron Star Symposium, Pulsars with the Next Generation Multi-element Telescopes : from the GMRT, to the SKA, BITS Hyderabad, India, January 7, 2018
7. Annual meeting of the Astronomical Society of India, The upgraded GMRT : Overview and Prospects for Pulsar Science, Hyderabad, India, February 8, 2018
8. AAPCOS-2018, Astrophysics at Low Radio Frequencies : from the uGMRT to the SKA, Kolkata, India, March 6, 2018
9. ThoughtWorks Symposium, Computational Astrophysics : Challenges and Opportunities, Pune, India, March 24, 2018

Joshi, Bhal Chandra

1. Looking for Gravitational Waves with a radio pulsar observatory - Indian Pulsar Timing Array experiment and TATA Pulsar Timing Array, Advances in Science, Engineering and Technology Colloquium, Tata Institute of Fundamental Research, Mumbai, April 28, 2017.
2. Panel Discussion on Characterizing GW sources, LIGO-India: The Road Ahead, Inter-University Center for Astronomy and Astrophysics, Pune, May 16, 2017.
3. Looking for Gravitational Waves with a radio pulsar observatory, 29th meeting of the Indian Association for General Relativity and Gravitation (IAGRG) - The Era of Gravitational Waves, Indian Institute of Technology, Guwahati, May 19, 2017 .
4. Introduction to radio pulsars/neutron stars , Pulsar Astronomy with uGMRT Boot-Camp, BITS-Pilani, Hyderabad Campus, Hyderabad, January 3 and 4, 2018
5. Pulsar timing technique and its applications to neutron star astronomy, Pulsar Astronomy with uGMRT Boot-Camp, BITS-Pilani, Hyderabad Campus, Hyderabad, January 3 and 4, 2018
6. Simultaneous multi-frequency wide-band observations of Four musketeers with legacy and upgraded GMRT, Multi-Wavelength Neutron Star Workshop, BITS-Pilani, Hyderabad Campus, Hyderabad, January 7, 2018.
7. Multi-epoch multi-frequency monitoring of pulsars with ORT and GMRT, NCRA Academic day, NCRA-TIFR, Pune, January 18, 2018.
8. Precision pulsar timing with the ORT and the GMRT and its applications in pulsar astrophysics, Advances in Astroparticle Physics and Cosmology (AAPCOS-2018), Saha Institute of Nuclear Physics, Kolkata, March 7, 2018

Kharab, Preeti

1. A Low Frequency Study of Seyfert Galaxies, Quasar Tea seminar, CfA, Cambridge USA, June 2017.
2. Probing the Origin of Radio Outflows in Seyferts and LINERs (Contributed), When Brandeis met Jansky: astrophysics and beyond, Brandeis University, Waltham MA USA, June 28-30, 2017.
3. A Parsec-scale Look at the Central Regions of Low Luminosity AGN, AstroSat View of AGN Central Engines, IUCAA, Pune, December 18-21, 2017.
4. Radio View on AGN, Franco-Indian Astronomy School, From Re-ionization to Large Scale Structure: A Mutliwavelength Approach, IUCAA, Pune, February 11-17, 2018.
5. A Multi-scale Study of Outflows from Low Luminosity AGN, Energetics and Life-Cycles of Radio Sources, ASTRON, the Netherlands, March 26-28, 2018.

Kanekar, Nissim

1. Cold Gas at High Redshifts, East Asia ALMA Meeting, Daejeon, South Korea; November 2017.

2. The gas mass and star formation rate of star-forming galaxies at z>1, TMT Science Forum 2017, Mysuru; September 2017.
3. The Gas Mass and Star Formation Rate of Star-forming Galaxies at z~1.3, The Plasma Universe and its Structure Formation workshop, Inter-University Centre for Astronomy and Astrophysics, Pune; August 2017.
4. Absorbing Galaxies at High Redshifts, JvGFest 2017: Gas and Galaxy Evolution conference, Idaho, USA; August 2017.

Kale, Ruta

1. Discovery of a radio relic in a low mass Planck cluster, Conference Physics of the Intra-Cluster Medium, Beijing, China, April 3 – 7, 2017.
2. Understanding the intra-cluster medium through radio surveys of galaxy clusters, Colloquium, University of Montreal, Montreal, Canada, August 28, 2017.
3. Clusters of galaxies with the Upgraded GMRT, Plenary talk at the 36th Annual Meeting of the Astronomical Society of India, Osmania University, Hyderabad, India, February 5 – 9, 2018.
4. The Upgraded GMRT- Opening new windows to the radio Universe, Conference Snowcluster 2018-The Physics of Galaxy Clusters, Salt Lake City, Utah, USA, March 18 – 23, 2018.

Lal, Dharam Vir

1. GMRT upgrade: Current status and early science results, SKA Office, SKA South Africa, April 13, 2017.
2. A high resolution, high sensitivity, low radio frequency view of diffuse, low-surface brightness targets using upgraded GMRT, Istituto di Radioastronomia, INAF, Bologna, Italia, June 12, 2017.
3. The uGMRT summary, SPARCS VII: The Precursors Awaken, July 17-21, 2017.

Manoharan, P.K.

1. Current State of Reduced Solar Activity: Space Weather Events in the Inner Heliosphere, UN/US International Space Weather Initiative Workshop, Boston College, Chestnut Hill, MA, USA, August 1, 2017.
2. Space Weather activities in India, UN/US International Space Weather Initiative Workshop, Boston College, Chestnut Hill, MA, USA, August 3, 2017.
3. Ooty Radio Telescope – Studies on solar eruptions and quiet solar wind, Harvard-Smithsonian Center for Astrophysics, University Harvard, Cambridge MA, USA, August 7, 2017.
4. Studies of 3-D Solar Wind with the Ooty Radio Telescope, MIT Haystack Observatory, USA, August 8, 2017.
5. Propagation of coronal mass ejections, Space Weather Laboratory, NASA Goddard Space Flight Center, Greenbelt, USA, October 17, 2017.

6. Importance of solar wind turbulence index in understanding space weather events, Four-in-One Workshop on Tackling Outstanding Problems in Heliophysics and Space Weather, Clayton Hotel, Cardiff, Wales, UK, December 3, 2017.
7. Ooty Interplanetary Scintillation Studies of Solar wind and Space Weather events, Four-in-One Workshop on Tackling Outstanding Problems in Heliophysics and Space Weather, Clayton Hotel, Cardiff, Wales, UK, December 6, 2017.

Oberoi, Divya

1. SHI Science Update, MWA Project Meeting, Bologna, Italy, June 16-17, 2017
2. The Sun and Heliosphere at low radio frequencies Broad Impact of Low Frequency Science, Bologna, Italy, June 19-23, 2017
3. Coronal Heating Diagnostics from Low Radio Frequency Solar Observations, Annual Meeting of the Indian Plasma Society, Ahmedabad, November 7-10, 2017

Conference/ Workshop Organised by the School Department Group

Chandra/CIAO workshop, 23-27 October 2017

The NCRA-TIFR and the Chandra X-Ray Center (CXC) in Cambridge, USA had organised the workshop for Ph.D. students, post-doctoral fellows and early-career researchers in the field of Astronomy and Astrophysics to work with the Chandra Interactive Analysis of Observations (CIAO) software on Chandra observatory data. The workshop focussed on getting the most out of the Chandra data, including discussions of CIAO capabilities and the impact of calibration on cutting edge science. The aim was to provide an exposure to X-ray and radio astronomy using Chandra data as well as low frequency data from the upgraded Giant Metrewave Radio Telescope. *Organiser: Dharam Vir Lal*

Astrophysical Jets 2018 5th February, 2018

One-day (5 Feb 2018) workshop alongside the annual ASI 2018 meeting. The aim of the Astrophysical Jets 2018, workshop was to bring together researchers in the field of astrophysical jets for a focused one-day discussion on recent results and future directions for research. The workshop provided platform for extensive open discussion to focus on issues related to the production and nature of jets, not only in AGN, but also in micro-quasars and young stellar objects. *Organisers: Dharam Vir Lal and Preeti Kharb*

Radio Astronomy School (RAS)

The Radio Astronomy School was organised at NCRA, Pune from 28 August to 8 September 2017. *Organiser: Preeti Kharb*

Non DAE Research Projects

Principal Investigator: Bhal Chandra Joshi

Co-PI : P.K. Manoharan

Pulsar Monitoring Observations Program With The Upgraded Ooty Radio Telescope
Funding Agency : Science and Engineering Research Board, Department of Science and Technology

Principal Investigator: Ruta Kale

Unveiling non-thermal footprints of cluster assembly in the Universe,
DST-INSPIRE Faculty Award Project, Department of Science and Technology, 28 April 2015 – 27 April 2020 (5 years).

Principal Investigator: Gupta, Y

Indo – South African Joint Project on SKAI Telescope Manager test Environment and Simulation Framework Prototype (2016-2018)

Publications

In Journals

1 Aditya J. N. H. S. and Kanekar N., **A Giant Metrewave Radio Telescope search for associated HI 21 cm absorption in GHz-peaked-spectrum sources**, *Monthly Notices Of The Royal Astronomical Society*, 473, 59, 2018.

2 Baldi,,R.,D.; Williams,,D.,R.,A.; McHardy,,I.,M.; et al. and 29 coauthors including P. Kharb, LeMMINGs. I. **The eMERLIN legacy survey of nearby galaxies. 1.5-GHz parsec-scale radio structures and cores**, *Monthly Notices Of The Royal Astronomical Society*, 336,2018.

3 Basu A., Mao S. A., Fletcher A., Kanekar N., Shukurov A., et al. **Statistical properties of Faraday rotation measure in external galaxies - I. Intervening disc galaxies**, *Monthly Notices Of The Royal Astronomical Society*, 477, 2528, 2018.

4 Berton,,M.; Congiu,,E.; J,rvel,,,E.; Antonucci,,R.; Kharb,,P.; Lister,,M.,L.; Tarchi,,A.; Caccianiga,,A.; Chen,,S.; Foschini,,L.; and 7 coauthors, **Radio-emitting narrow-line Seyfert 1 galAxies in the JVLA perspective**, *Astronomy and Astrophysics*,2018.

5 Bhandari, S.; Keane, E. F.; Barr, E. D.;...Chandra, P.,... et al., T**he Survey for Pulsars and Extragalactic Radio Bursts - II. New FRB discoveries and their follow-up**, *Monthly Notices Of The Royal Astronomical Society*, 475, 1427, 2018.

6 Bonafede, A.; Cassano, R.; Brüggen, M.; Ogrean, G. A.; Riseley, C. J.; Cuciti, V.; de Gasperin, F.; Golovich, N.; Kale, R**.**; Venturi, T.; van Weeren, R. J.; Wik, D. R.; Wittman, D. **On the absence of radio haloes in clusters with double relics**, *Monthly Notices Of The Royal Astronomical Society*, 470, 3, 3465, 2017.

7 Chandra P. and Kanekar N., **Giant Metrewave Radio Telescope Monitoring of the Black Hole X-Ray Binary, V404 Cygni during its 2015 June Outburst**, *The Astrophysical Journal*, 846, 111, 2017.

8 Chandra, Poonam, **Circumstellar Interaction in Supernovae in Dense Environments? An Observational Perspective**, *Space Science Reviews*, 214, 27, 2018.

9 Chowdhury A., Chengalur J. N., **Angular momentum content in gas-rich dwarf galaxies**, *Monthly Notices of the Royal Astronomical Society*, 467 ,3856, 2017

10 Cohen, M. H. ; Aller, H. D. ; Aller, M. F. ; Hovatta, T. ; Kharb, P. ; Kovalev, Y. Y. ; Lister, M. L. ; Meier, D. L. ; Pushkarev, A. B. ; Savolainen, T., **Reversals in the Direction of Polarization Rotation in OJ 287, 862, 1**, *The Astrophysical Journal*, 2018

11 Cuciti, V.; Brunetti, G.; van Weeren, R.; Bonafede, A.; Dallacasa, D.; Cassano, R.; Venturi, T.; Kale, R**.**, **New giant radio sources and underluminous radio halos in two galaxy clusters**, *Astronomy & Astrophysics*, 609, 61, 2018.

12 Congiu,,E.; Berton,,M.; Giroletti,,M.; Antonucci,,R.; Caccianiga,,A.; Kharb,,P.; Lister,,M.,L.; Foschini,,L.; Ciroi,,S.; Cracco,,V., **Kiloparsec-scale emission in**

the narrow-line Seyfert 1 galaxy Mrk 783, *Astronomy and Astrophysics*, 603, 32,2017.

13 Cairns, I.H., V.V. Lobzin, A. Donea, S.J. Tingay, P.I. McCauley, D. Oberoi, …….. A. Roshi, N. Udaya Shankar, K.S. Srivani, R. Subrahmanyan, R.B. Wayth, M. Waterson, R.L. Webster, A.R. Whitney, A. Williams, and C.L. Williams, **Low Altitude Solar Magnetic Reconnection, Type III Solar Radio Bursts, and X-ray Emissions**, *Nature Scientific Reports*, 8, 1676, 2018.

14 Castelletti, G., Supan, L., Petriella, A., Giacani, E., and Joshi, B. C., **Radio and X-ray properties of the source G29.37+0.1 linked to HESS J1844-030**, *Astronomy & Astrophysics* 602, A31, 2017.

15 Castelletti, G., Supan, L., Petriella, A., Giacani, E., and Joshi, B. C., **VizieR Online Data Catalog: G29.37+0.1 610MHz image (Castelletti+, 2017)**, *yCat*, 360, 2017

16 Das,,M.; Rubinur,,K.; Kharb,,P.; Varghese,,A.; Navyasree,,K.; James,,A. **Dual Active Galactic Nuclei in Nearby Galaxies**, *Bulletin de la Soci,t, Royale des Sciences de Li,ge*, 87, 299-306 , 2017

17 Davies,,R.,L.; Groves,,B.; Kewley,,L.,J.; Medling,,A.,M.; Shastri,,P.; Maithil,,J.; Kharb,,P.; Banfield,,J.; Longbottom,,F.; Dopita,,M.,A.; and 7 coauthors, **Dissecting galaxies: separating star formation, shock excitation and AGN activity in the central region of NGC 613**, *Monthly Notices Of The Royal Astronomical Society*, 470, 4974,2017

18 Deo, Deepak Kumar; Kale, Ruta, **Simulations of imaging extended sources using the GMRT and the U-GMRT. Implications to observing strategies**, *Experimental Astronomy*, 44, 165, 2017

19 Das, Barnali; Chandra, Poonam; Wade, Gregg A., **Discovery of electron cyclotron MASER emission from the magnetic Bp star HD 133880 with the Giant Metrewave Radio Telescope**, *Monthly Notices Of The Royal Astronomical Society Letter* 464, L61, 2018

20 Diamond, P. & Gupta, Y.,**India and the Square Kilometre Array**, *Current Science*, 113, 649,2017

21 Feng, L., Vaulin, R., Hewitt, J. N., Remillard, R., Kaplan, D. L., Murphy, T. Kudryavtseva, N., Hancock, P., Bernardi, G., Bowman, J. D., Briggs, F., Cappallo, R. J., Deshpande, A. A., Gaensler, B. M., Greenhill, L. J., Hazelton, B. J., Johnston-Hollitt, M., Lonsdale, C. J., McWhirter, S. R., Mitchell, D. A., Morales, M. F., Morgan, E., Oberoi, D., Ord, S. M., Prabu, T., Udaya Shankar, N., Srivani, K. S., Subrahmanyan, R., Tingay, S. J., Wayth, R. B., Webster, R. L., Williams, A. and Williams, C. L., **A Matched Filter Technique for Slow Radio Transient Detection and First Demonstration with the Murchison Widefield Array**, *The Astronomical Journal*, 153, 98, 2017

22 Grainge, K., and 44 couathors (including Gupta, Y.) , **Square Kilometre Array: The radio telescope of the XXI century**, *Astronomy Reports*, 61,No. 4, 288, 2017

23 Gupta, Y. et al., **The upgraded GMRT: opening new windows on the radio Universe,** *Current Science*, 113, 707, 2017

24 Hekatelyne,,C.; Riffel,,R.,A.; Sales,,D.; Robinson,,A.; Gallimore,,J.; Storchi-Bergmann,,T.; Kharb,,P.; O'Dea,,C.; Baum,,S., **Gemini IFU, VLA, and HST observations of the OH megamaser galaxy IRAS F23199+0123: the hidden monster and its outflow**, *Monthly Notices Of The Royal Astronomical Society*, 474, 5319,2018

25 Hallinan, G.; Corsi, A.; Mooley, K. P.; ...Chandra, P., **A radio counterpart to a neutron star merger......et al**. *Science*, 358, 1759, 2017

26 Ibrahim, M.S., Manoharan, P.K., Shanmugaraju, A., **Propagation of Coronal Mass Ejections Observed During the Rising Phase of Solar Cycle 24**, *Solar Physics*, volume 292, 133

27 Iqbal, Asif; Kale, Ruta; Majumdar, Subhabrata; Nath, Biman B.; Pandge, Mahadev; Sharma, Prateek; Malik, Manzoor A.; Raychaudhury, Somak, **Active Galactic Nucleus Feedback with the Square Kilometre Array and Implications for Cluster Physics and Cosmology**, *Journal of Astrophysics and Astronomy*, 38, 68, 2017

28 Kakkad, D.; Groves, B. .; Dopita, M. ; Thomas, A. D. ; Davies, R. L. ; Mainieri, V. ; Kharb, P. ; Schwarwaechter, J. ; Hampton, E. J. ; I-Ting Ho, **Spatially resolved electron density in the Narrow Line Region of low-z Active Galactic nuclei**, 2018, A&A

29 Kapinska, A. D., Staveley-Smith, L., Crocker, R., Meurer, G. R., Bhandari, S., Hurley-Walker, N., Offringa, A. R., Hanish, D. J., Seymour, N., Ekers, R. D., Bell, M. E., Callingham, J. R., Dwarakanath, K. S., ………. Oberoi, D., Ord, S. M., Prabu, T., Srivani, K. S., Williams, A. and Williams, C. L., **Spectral Energy Distribution and Radio Halo of NGC 253 at Low Radio Frequencies**, *The Astrophysical Journal*, 838, 68, 2017

30 Kale, Ruta; Wik, Daniel R.; Giacintucci, Simona; Venturi, Tiziana; Brunetti, Gianfranco; Cassano, Rossella; Dallacasa, Daniele; de Gasperin, Francesco, **Discovery of a radio relic in the low mass, merging galaxy cluster PLCK G200.9-28.2,** *Monthly Notices of the Royal Astronomical Society*, 472, 940, 2017

31 Kanekar N., Ghosh T., Chengalur J. N., Stringent Constraints on Fundamental Constant Evolution Using Conjugate 18 cm Satellite OH Lines, *Physics. Rev. Lett*er., 120, 061302 2018

32 Kanekar N., Neeleman M., Prochaska J. X., Ghosh T., **The gas and stellar mass of low-redshift damped Lyman-alpha absorbers**, *Monthly Notices Of The Royal Astronomical Society -Letters*, 473, L54 2018

33 Kanekar N., J. X. Prochaska, L. Christensen, et al., **Massive, Absorption-selected Galaxies at Intermediate Redshifts**, *The Astronomical Journal-Letter*, 856, L23, 2018.

34 Kanekar N., Ghosh T., Chengalur J. N., **Stringent Constraints on Fundamental Constant Evolution Using Conjugate 18 cm Satellite OH Lines**, *Physical Review Letters*, 120 ,061302, 2018

35 Kharb,,P.; Lal,,D.,V.; Merritt,,D., **A candidate sub-parsec binary black hole in the Seyfert galaxy NGC 7674**, *Nature Astronomy*, 1, 727,2017.

36 Kharb,,P.; Subramanian,,S.; Vaddi,,S.; Das,,M.; Paragi,,Z. **Double-peaked Emission Lines Due to a Radio Outflow in KISSR 1219**, *The Astrophysical Journal*, 846, 12, 2017

37 Kharb, P., Lal, D.V. & Merritt, D., **A candidate sub-parsec binary black hole in the Seyfert galaxy NGC 7674**, *Nature Astronomy*, 1, 727, 2017

38 Kudale S., Chengalur J. N., **Phased array observations with infield phasing**, *Experimental Astronomy*, 44 ,97, 2017

39 Krishnakumar, M.A., Joshi, B.C., Basu, A., Manoharan, P.K., **ORT observations of the recent glitch in the Crab pulsar**, *The Astronomer's Telegram*, No. 10947, 2017

40 Krishnakumar, M.A., Joshi, B.C., and Manoharan, P.K., **Multi-frequency Scatter Broadening Evolution of Pulsars I**, *The Astrophysical Journal*, 846,104,2017

41 Maan, Y., Krishnakumar, M.A., Naidu, A., Roy,S. Joshi, B.C., Kerr, M., Manoharan, P.K. **Detection of radio emission from the gamma-ray pulsar J1732−3131 at 327 MHz**, *Monthly Notices of the Royal Astronomical Society*, 471, 541-547

42 Maitra, C.; Roy, S.; Acero, F.; Gupta, Y., **Discovery of a radio nebula around PSR J0855-4644**, *Monthly Notices of the Royal Astronomical Society*, 2018

43 Morgan, J.S., Macquart, J.-P., Ekers,V, Chhetri, R,. Tokumaru, M., Manoharan, P.K., Tremblay, S., Bisi, M.M., Jackson, B.V., **Interplanetary Scintillation with the Murchison Widefield Array I: a sub-arcsecond survey over 900 deg^2 at 79 and 158 MHz**, *Monthly Notices of the Royal Astronomical Society*, 473, 2965–2983, 2018

44 Marthi V. R., Chatterjee S., Chengalur J. N., Bharadwaj S**., Simulated predictions for H I at z = 3.35 with the Ooty Wide Field Array - I. Instrument and the foregrounds**, *Monthly Notices of the Royal Astronomical Society*, 471 ,3112, 2017

45 Moller P., Christensen L., Zwaan M. A., Kanekar N., et al., **ALMA + VLT observations of a damped Lyman-alpha absorbing galaxy: massive, wide CO emission, gas-rich but with very low SFR**, *Monthly Notices of the Royal Astronomical Society*, 474, 4039, 2018

46 Mooley, K. P.; Nakar, E.; Hotokezaka, K.;...Chandra, P.... et al., **Evidence for a mildly relativistic wide-angle outflow in the radio after- glow of GW170817**, *Nature*, 554, 207, 2018

47 Mohan, A. and Oberoi, D., **4D radio data cubes from spectroscopic-snapshot imaging,** *Solar Physics*, 292, 168, 2017

48 Mohan, N., Roy, S., Swarup, G., Oberoi, D., Ramanujam, N. M., Raju, S. C. and Bharadwaj, A., **Radio observations of Venus at metre wavelengths using the GMRT,** *ICARUS*, 297, 119-125, 2017.

49 Naidu, A., Joshi, B.C., Manoharan, P.K., Krishnakumar, M.A**., Detection of long nulls in PSR B1706−16, a pulsar with large timing irregularities**, *Monthly Notices of the Royal Astronomical Society*, 475, 2375-2382

50 Naidu, A., Joshi, B. C., Manoharan, P. K., and Krishnakumar, M. A. **Simultaneous multi-frequency single pulse observations of pulsars**, *Astronomy & Astrophysics*, 604, A45, 2017

51 Neeleman M., Kanekar N., Prochaska J. X., et al., **Molecular Emission from a Galaxy Associated with a z~2.2 Damped Ly-alpha Absorber**, *The Astrophysical Journal Letter*, 856, L12, 2018

52 Oberoi, D., Sharma, R. and Rogers, A. E. E., **Estimating Solar Flux Density at Low Radio Frequencies Using a Sky Brightness Model**, *Solar Physics*, 292, 75, 2017

53 Patrick I. McCauley, Iver H. Cairns, John Morgan, Sarah E. Gibson, James C. Harding and Divya Oberoi, **Type-III solar radio burst source region splitting due to a quasi-sepratrix layer**, *The Astrophysical Journal*, 851, 151, 2017

54 Petroff, E.; Burke-Spolaor, S.; Keane, E. F.;.... Chandra, P., ...et al**., A polarized fast radio burst at low Galactic latitude**, *Monthly Notices of the Royal Astronomical Society*, 469, 4465, 2017

55 Ponti, G. et al., **NuSTAR + XMM-Newton monitoring of the neutron star transient AX J1745.6-2901**, *Monthly Notices of the Royal Astronomical Society*, 473, 2304, 2018

56 Rhee J., Lah P., Briggs F. H., Chengalur J. N., Colless M., Willner S. P., Ashby M. L. N., Le Fèvre O., **Neutral hydrogen (HI) gas content of galaxies at z ~ 0.32**, *Monthly Notices of the Royal Astronomical Society*, 473 ,1879, 2018

57 Roychowdhury S., Chengalur J. N., Shi Y**., Extended Schmidt law holds for faint dwarf irregular galaxies**, *Astronomy and Astrophysics*, 608 ,A24, 2017

58 Rubinur,,K.; Das,,M.; Kharb,,P. **Searching for dual active galactic nuclei**, *Journal of Astrophysics and Astronomy*, 39, 8,2018

59 Safutdinov, E. R.; Popov, M. V.; Gupta, Y.; Mitra, D.; Kumar, U., **Secondary dynamical spectra of pulsars as indicators of inhomogeneities in the interstellar plasma**, *Astronomy Reports*, 61, No. 4, 406,2017

60 Sebastian, B., Lal, D.V. & Pramesh R.A., **Giant Metrewave Radio Telescope Observations of Head-Tail Radio Galaxies**, *The Astrophysical Journal*, 154, 169, 2017

61 Sharma, R., Oberoi, D. and Arjunwadkar, M., **Quantifying weak non-thermal solar emission at low radio frequencies**, *The Astrophysical Journal*, 852, 69, 2017

62 Sharma, R., Mitra, D. and Oberoi, D**., On the energization of charged particles by fast magnetic reconnection**, *Monthly Notices of the Royal Astronomical Society*, 470, 723--731, 2017

63 Suresh, A., Sharma, R., Oberoi, D., Das, S. B., Pankratius, V., Timar, B., Lonsdale, C. J., Bowman, J. D., Briggs, F., Cappallo, R. J., Corey, B. E., Deshpande, A. A., Emrich, D., Goeke, R., Greenhill, L. J., Hazelton, B. J., Johnston-Hollitt, M., Kaplan, D. L., Kasper, J. C., Kratzenberg, E., Lynch, M. J., McWhirter, S. R., Mitchell, D. A., Morales, M. F., Morgan, E., Ord, S. M., Prabu, T., Rogers, A. E. E., Roshi, A., Udaya Shankar, N., Srivani, K. S., Subrahmanyan, R., Tingay, S. J., Waterson, M., Wayth, R. B., Webster, R. L., Whitney, A. R.,

Williams, A. and Williams, C. L., **Wavelet-based Characterization of Small-scale Solar Emission Features at Low Radio Frequencies**, *The Astrophysical Journal*, 843, 19, 2017

64 Thomas,,A.,D.; Dopita,,M.,A.; Shastri,,P.; Davies,,R.; Hampton,,E.; Kewley,,L.; Banfield,,J.; Groves,,B.; James,,B.,L.; Jin,,C.; and 8 coauthors including P. Kharb, **Probing the Physics of Narrow-line Regions in Active Galaxies. IV. Full Data Release of the Siding Spring Southern Seyfert Spectroscopic Snapshot Survey (S7),** *The Astrophysical Journal Supplement Series*, 232, 11,2017

65 Vadawale, V., Chattopadhyay, T., Mithun, N. P.S., Rao, A.R., Bhattacharya, D., Vibhute, A., Bhalerao, V.B., Dewangan, G.C., Misra, R., Paul, B., Basu, A., Joshi, B.C., Sreekumar, S., Samuel, E., Priya, P., Vinod, P., and Seetha, S., **Phase-resolved X-ray polarimetry of the Crab pulsar with the AstroSat CZT Imager**, *Nature Astronomy*, 2, 50, 2018

66 Venturi, T. et al., **The two-component giant radio halo in the galaxy cluster Abell 2142**, *Astronomy and Astrophysics*, 603, 125, 2017

67 Wu, J., Clark, C. J., Pletsch, H. J., Guillemot, L., Johnson, T. J., Torne, P., Champion, D. J., Deneva, J., Ray, P. S., Salvetti, D., Kramer, M., Aulbert, C., Beer, C., Bhattacharyya, B., Bock, O., Camilo, F., Cognard, I., Cullar, A., Eggenstein, H. B., Fehrmann, H., Ferrara, E. C., Kerr, M., Machenschalk, B., Ransom, S. M., Sanpa-Arsa, S., Wood, K., **The Einstein@Home Gamma-Ray Pulsar Survey II. Source Selection, Spectral Analysis and Multi-wavelength Follow-up,** *The Astrophysical Journal*, 554,99, 2018

In Proceedings

1 Botteon, Andrea; Brunetti, Gianfranco; Dallacasa, Daniele; Gastaldello, Fabio; Kale, Ruta, **Non-Thermal Phenomena In El Gordo At z=0.87, Early stages of Galaxy Cluster Formation (GCF)**, 35, 2017

2 Cano, Zach; Kuin, Paul; Chandra, Poonam; Ashall, Chris; Malesani, Daniele; Pastorello, Andrea, **Swift and LT UV and optical observations of type IIn superluminous supernova 2017gir**, , ATel 10784, 2017

3 Chandra, Poonam, **Radio and X-ray observations of supernovae in dense environments, Supernova 1987A:30 years later - Cosmic Rays and Nuclei from Supernovae and their aftermaths, Proceedings of the International Astronomical Union,** IAU Symposium, 331, 23-32, 2017

4 Chandra, Poonam; Fransson, Claes; Chevalier, Roger A., **Swift-XRT observations of Type IIn supernova SN 2017hcc**, ATel 10936, 2017

5 Chandra, Poonam; Chevalier, Roger A., Swift-XRT observations of Type IIn supernova ASASSN-17kr a.k.a. SN 2017gas, ATel 10705, 2017

6 Chandra, P.; Nayana, A. J.; Bhattacharya, D.; Cenko, S. B.; Corsi, A. , **GMRT Radio detection of GRB 171205A, 2018 GCN 22264**

7 Chandra, P.; Nayana, A. J.; Bhattacharya, D.; Cenko, S. B.; Corsi, A**., GMRT upper limit on GRB 171205A, GCN 22222**, 2017

8 Chandra, P.; Nayana, A. J., **GMRT upper limit on the radio afterglow of GRB 170728B,** GCN 21441, 2017

9 Krishnakumar, M. A., Joshi, Bhal Chandra, Basu, A., and Manoharan, P. K**., ORT observations of the recent glitch in the Crab pulsar,** ***ATel1***, 10947, 2017

10 Nayana, A. J.; Chandra, Poonam, **GMRT observations of a Type II supernova SN 2017hpi**, ATel 11016 , 2017

11 Nayana, A. J.; Chandra, Poonam, **GMRT radio upper limits on Type IIn supernova SN 2017hcc,** ATel 11015, 2017

12 Nayana, A. J.; Chandra, P, **GMRT radio detection of a type II supernova SN 2017eaw**, ATel 10534, 2017

13 Nayana, A. J.; Chandra, P., **Low frequency GMRT observations of supernova SN 2017eaw**, ATel 10388, 2017

14 Lonsdale, C.; Benkevitch, L.; Cairns, I.; Crowley, M.; Erickson, P.; Knapp, M.; Kozarev, K.; Lind, F.; McCauley, P.; Morgan, J.; Oberoi, D., **Solar Imaging using Low Frequency Arrays, Proceedings of "8th International Workshop on Planetary, Solar and Heliospheric Radio Emissions** (PRE VIII)", 2018

15 Ramaila, A.; Gupta, Y.; Patwari, P.; Roy Chaudhuri, S.; Madisa, K.; Marais, N.; Banerjee, **A., Control System Simulation Using DSEE High Level Instrument Interface and Behavioural Description, 16th International Conference on Accelerator and Large Experimental Physics Control Systems (ICALEPCS 2017**), 292,2018

16 Sokolovsky, K.; Wyrzykowski, L.; Hamanowicz, A.; Gromadzki, M.; Chandra, P.; Tonry, J.; Stalder, B.; Denneau, L.; Heinze, A.; Weiland, H.; Rest, A.; Smith, K. W.; Smartt, S. J.; Young, D., **Swift and ATLAS observations of ASASSN-17fy/SN2017dwq**, ATel 10500, 2017

17 Warange, R.; Braddock, R.; Grainge, K.; Gupta, Y.; Hammond, J.; Horn, U.; Mant, G., **SKA Synchronization and Timing Local Monitor Control - Project Status,16th International Conference on Accelerator and Large Experimental Physics Control Systems (ICALEPCS 2017**), 1582, 2018

In Books

NIL

Telegrams, circulars

NIL

Research Papers

NIL

Technical Reports/Internal Reports

1. 2017, Matlab-based GUI for Data Analysis of Real-time RFI Filtering System, Dhaigude, Aishwarya; Desai, Ankita
2. 2017, Interface Of Adis16362 Inertial Sensor With Raspberry Pi, Arun, Satheesh
3. 2017, Symptoms of gear box failure and condition monitoring, Abhijnan Dutta
4. 2017, WEB APPLICATION TOOLS FOR RFI DATA, Suvidha Subhash Kavale
5. 2017, CHARACTERIZATION OF NEW BROADBAND FEEDS FOR GMRT, Sanket Bhor
6. 2017, Recommended Attenuation Setting for GAB system, Prakash Hande
7. 2017, Internal Technical Report on GAB attenuator test, Sudhir Phakatkar

Lectures/Lecture Courses Given Elsewhere

Bhattacharyya, Bhaswati

1. Pulsars and transients, VSRP, NCRA Pune June 2,2017
2. Pulsars, Radio Astronomy School, NCRA, Pune, August 29, 2017
3. Demonstration on pulsar timing analysis with real and simulated data, Radio Astronomy School, NCRA, Pune August 31, 2017.
4. Introduction to experiment on detection of 21 cm signal using 4-m telescope and horn antenna, Radio Astronomy Winter school, NCRA, Pune December 18,2017
5. Conducted experiment for detection of 21 cm signal using 4-m telescope, Radio Astronomy Winter school, NCRA, Pune, December, 18 – 22, 2017

Gupta, Yashwant

1. Introduction to the GMRT, Radio Astronomy School, NCRA, Pune, August 4, 2017
2. The Square Kilometre Array Project, Tenth Radio Astronomy Winter School, NCRA, Pune, December 22, 2017
3. The upgraded GMRT : Opening new windows to the low frequency radio Universe, Max Planck Institute for Radio Astronomy, Bonn, Germany, November 7, 2017.

Kanekar, Nissim

1. Do the Fundamental Constants change with time?, National Institute of Science Education and Research, Bhubaneswar; March 2018.
2. Do the Fundamental Constants change with time? , Ashoka University, Haryana; March 2018.
3. Do the Fundamental Constants change with time? , Physics Department, S. P. Pune University, Pune; October 2017.
4. Science with the Upgraded GMRT, TIFR Founder's Day Colloquium, TIFR-Mumbai; October 2017.
5. Do the Fundamental Constants change with time?, Presidency University, Kolkata; October 2017.
6. Do the Fundamental Constants change with time?, Vikram Sarabhai Award Colloquium, Physical Research Laboratory, Ahmedabad; June 2017.
7. Cold Gas at High Redshifts , PRL Astronomy Colloquium, Physical Research Laboratory, Ahmedabad; June 2017.

Seminars

8. Cold Gas at High Redshifts, Columbia University, New York, USA; April 2018.
9. Cold Gas at High Redshifts, National Radio Astronomy Observatory, Socorro, USA; April 2018.

10. Do the Fundamental Constants change with time?, Indian Institute of Science Education and Research, Pune; January 2018.

Kharab, Preeti

1. Writing a GMRT Proposal, Radio Astronomy School at NCRA, 28 August - 8 September 2017.
2. X-rays from AGN Jets, Chandra CIAO Workshop, NCRA, 23-27 October 2017.

Lal, Dhram Vir

1. The GMRT project: science and technology aspects, (Two lectures), School of Physical Sciences, S.R.T.M. University, Nanded, August 8, 2017

Lectures by Visitors

1. Anupreeta More, (*Kavli IPMU, Japan*, Probing the dark side of the Universe with strong gravitational lensing, April 3, 2017
2. L. Sriramkumar, (*Indian Institute of Technology Madras, Chennai*), Can inflation be falsified?, April 10, 2017
3. Samir Choudhuri, (*NCRA-TIFR*), Visibiity-based power spectrum estimation for low-frequency radio interferometric observations., April 24, 2017
4. Eric Hooper, (*University of Wisconsin-Madison & WIYN Observatory, USA*), A 3-D view into the Connection and History of Galaxies and Active Galactic Nuclei, June 5, 2017
5. Pawan Kumar, (*University of Texas-Austin, USA*), Exploring the Progenitors of long-duration Gamma Ray Bursts, July 5, 2017
6. Jonathan Granot, (*The Open University of Israel, Israel*), Experimental Bounds on Quantum Gravity from Fermi Observations of GRBs, July 10, 2017
7. Anish Roshi, (*National Radio Astronomy Observatory, USA)*, Highly Sensitive Cryogenic Phased Array Feed, July 14, 2017
8. Manjari Bagchi, (*Institute of Mathematical Sciences, Chennai*), Binary radio pulsars with compact companions to understand basic physics, July 28, 2017
9. K. P. Singh, (*TIFR-Mumbai*), X-ray Spectroscopy in Astronomy, July 31, 2017
10. Dale Frail, (*National Radio Astronomy Observatory, Socorro, USA*), Fracking for pulsars, August 4, 2017
11. Paula Benaglia, (*Argentine Institute of Radio Astronomy, Argentina)*, Massive stars with the GMRT., August 21, 2017
12. Uma Ramakrishnan, (*National Centre for Biological Sciences, Bengaluru*), Are genomic data relevant for conservation?, September 4, 2017
13. Huib Intema, (*University of Leiden, The Netherlands*, From black belt to novice: Enabling astrophysics with the GMRT, September 11, 2017
14. Kajari Mazumdar, (*TIFR-Mumbai*), The Large Hadron Collider , LHC, project., September 18, 2017
15. K. Hariharan, (*NCRA-TIFR, Pune*), Multi-resolution Studies of Solar Radio Transients, September 25, 2017
16. Satish Sonkamble, (*NCRA-TIFR, Pune)*, AGN Feedback in Galaxy Clusters, September 29, 2017
17. Amitava Raychaudhuri, (*University of Calcutta, Kolkata*), Balancing the left with the right: The road to unity, October 3, 2017
18. Carlos Wuensche, (*National Institute for Space Research, Brazil)*, The BINGO radio telescope and the 21 cm Cosmology, October 6, 2017
19. Rajesh Mondal, (*NCRA-TIFR,Pune)*, Statistics of the Epoch of Reionization 21cm signal: The non-Gaussian effects on the power spectrum error predictions, October 13, 2017
20. Pravabati Chingangbam, (*Indian Institute of Astrophysics, Bengaluru*), Studying Cosmological Fields with Minkowski Tensors, October 16, 2017

21. Shiraz Minwalla, (*TIFR, Mumbai)*, Hydrodynamics and Membrane Dynamics from Gravity, October 20, 2017
22. Michael Nowak, MIT Kavli Institute for Astrophysics and Space Research, USA, Are Black Holes as simple as they used to be?, October 23, 2017
23. Rodolfo Montez, Smithsonian Astrophysical Observatory, USA, Insights into Binary Stars, Stellar Winds, and Astrophysical Plasmas from X-ray Observations of Planetary Nebulae, October 24, 2017
24. Sourabh Paul, *(NCRA-TIFR, Pune)* Towards the measurement of 21cm HI power spectrum from the Epoch of Reionization, October 30, 2017
25. K. G. Arun, (*Chennai Mathematical Institute, Chennai*), Tale of a binary neutron star merger, November 13, 2017
26. Vishal Gajjar, (*University of California, Berkeley*), USA, A new insight into the origin of repeating fast radio bursts, November 24, 2017
27. Debades Bandyopadhyay, (*Saha Institute of Nuclear Physics, Kolkata)*, Neutron Star Equation of State and Maximum Mass: Lessons from GW170817, December 4, 2017
28. Aritra Basu, (*Bielefeld University, Germany*), Magnetic Fields in High-Redshift Galaxies, December 15, 2017
29. Frank Shu, (*University of California, Berkeley and San Diego, USA*); National Tsing Hua University, China, Formation of Sunlike Stars and Planetary Systems, December 18, 2017
30. Andy Fabian, (*Institute of Astronomy, Cambridge, UK*), AGN Feedback, December 20, 2017
31. Nipanjana Patra, (*University of California, Berkeley, USA*), Precision measurement challenges of 21cm Cosmology, February 2, 2018
32. Viswesh R. Marthi, (*Canadian Institute of Theoretical Astrophysics, Canada*), Imaging with Interstellar Baselines, February 23, 2018
33. Ruta Kale, *(NCRA-TIFR, Pune)* Cosmic Rays and Magnetic Fields in Galaxy Clusters, March 12, 2018
34. Bhaswati Bhattacharyya, *(NCRA-TIFR, Pune)* A long-term study of Rotating Radio Transients, March 19, 2018

Seminar

1. Sravani Vaddi, *(NCRA-TIFR, Pune)* Ghost ionization in the cooling flow filaments of galaxy clusters, April 17, 2017
2. Dipanjan Mukherjee, (*Australian National University*), Simulating the jet-ISM interaction in GPS and CSS galaxies., September 19, 2017
3. Deepthi Gorthi, (*University of California, Berkeley, USA*), Building an FFT Correlator for the Hydrogen Epoch of Reionization Array, November 27, 2017
4. Kshitij Thorat, (*Rhodes University, South Africa*), Seize the means of reduction : Making Containerised Pipelines for Radio Interferometric Data, December 11, 2017

5. Maitraiyee Tiwari, (*Max Planck Institute for Radio Astronomy*, *Bonn*, *Germany*), Unveiling the remarkable photodissociation region of M8, December 15, 2017
6. Ayan Acharyya, (*Australian National University*, *Australia*), Inferring ISM conditions in high-z universe from rest-frame UV spectra I: applying UV diagnostics on bright lensed galaxy at z~1.7, December 19, 2017
7. Kimberley Emig, (*University of Leiden*, *The Netherlands*), Cold HI, near and far, with low-frequency recombination lines, January 12, 2018
8. Kameswara Mantha, (*University of Missouri*, *Kansas City*, *USA*), Towards a Robust Major Merger History of Massive Galaxies, February 16, 2018

Graduate Courses

Chengalur, Jayaram

Advanced Radio Astronomy, NCRA-IUCAA graduate school, Mar-Apr 2018

Chandra, Poonam

Radio and X-ray Astronomy", 12 hours course to advanced Ph.D. students of Stockholm University, Spring 2018

Joshi, B.C.

Supervised Short term projects

1. Suryarao Bethapudi
2. Sai Chaitanya Susarala
3. Debashish Jena
4. Ashutosh Padelkar

Kanekar, Nissim

Guided

i) Atrideb Chatterjee, Barnali Das, and Minhajur Rahaman, NCRA-TIFR graduate school students, 3-month graduate school research projects, October 2017 January 2018.

ii) Pranav Kukreti and Vandana Ramakrishnan on VSRP projects, May-July, 2017.

Kale, Ruta

Guided

i) "Comparing thermal and non-thermal components in galaxy clusters", M. Sc. Thesis at Savitribai Phule Pune University by Mr. Pankaj Kailas Patil, Fergusson College, May 2017.

Oberoi, Divya

i) Lecture at the Radio Astronomy Winter School, NCRA

ii) Lecture for the Visiting Student Research Programme, NCRA

Ph.D. Theses / M.Sc. Theses

Joshi, Bhal Chandra

Surnis, Mayuresh, Ph.D., Radio Pulsar Search and Timing , 2017, NCRA-TIFR Pune,
Naidu, Arun Kumar, Ph.D., Pune, Single pulse studies of radio pulsars resulting from a newly developed pulsar instrument at the Ooty Radio Telescope, 2017, NCRA-TIFR

Lal, Dhram Vir

Satish S. Sonkamble, Ph.D., Investigation of X-ray cavities in optically normal Galaxies, University: School of Physical Sciences, S.R.T.M.University, Nanded.

Choudhury, Tirthankar Roy

Gaikwad, Prakash, Ph.D, 2017, Efficient hydrodynamical simulations of the intergalactic medium and parameter estimation, NCRA-TIFR

Bhattacharyya, Bhaswati

Sukriti Arya M.Sc., 2017-2018, Savitribai Phule Pune University
Namrata Malusare, M.Sc., 2017-2018, Savitribai Phule Pune University

Gupta, Yashwant
Krishna Shinde, M.Sc., 2017 -2018, Savitribai Phule Pune University

Popular Science Articles / Lectures

Any other information

Manoharan, P.K.

Student Training Programme: During this period (in the month of June 2018), we conducted one-week training programme at RAC for ~50 students of the first- and second-year bachelor science/engineering studnets. This programme includesd lectures on astrophysical and engineering aspects of radio astronomy and visits to RAC facilities.

National Science Day 2018 at RAC: As one of our public outreach activities, we organized the National Science Day at the RAC on 28 February 2018. This programme included several attractions, such as (i) demonstration of the Ooty Radio Telescope's mechanical, electrical, and electronics systems, (ii) watching the live observations of celestial objects using the ORT, (iii) observing the Sun and tracking its sunspots, (iv) demonstrations and exhibits on recent advances and developments in astronomy and astrophysics, (v) exhibits and demonstrations from other scientific and research organizations of the Nilgiri District, and (vi) Selected science models from schools and paintings made by students. In association with the RAC Science Day, science awareness events were also conducted at RAC for school students on 08 February 2018 and ~800 students from about 80 schools participated in these events. The Science Day programme on 28 February 2018 was inaugurated by Ms Innocent Divya, the District Collector, Nilgiri District. It was our sixth science day programme at RAC and was a very successful event.

College Students' Visit to RAC: During the period of the report, nearly about 20,000 students and faculty members of engineering/science colleges/universities (i.e., nearly 250 batches of students) from all over the country made educational visits to the RAC. For these students, we arranged the video on radio astronomy and one of the members of the institute explained the facilities at RAC.

Radio & TV Programmes

Chandra, Poonam

1. Swedish Science Radio, 21 December 2017 (https://sverigesradio.se/sida/artikel.aspx?programid=406&artikel=6847633)
2. Swedish Science Radio, 22 December 2017 (https://sverigesradio.se/sida/avsnitt/993660 programid=415)

News Items in the Press

1. The Indian Express, Pune, Anjali Marar, April 20, 2017
https://indianexpress.com/article/explained/nissim-kanekar-interview-peek-into-how-galaxies-like-milky-way-looked-12-billion-years-ago-4620172/
Peek into how galaxies like Milky Way looked 12 billion years ago

2. The Indian Express, Narayangaon/Pune, Anjali, Marar, May 29, 2017
https://indianexpress.com/article/india/come-2018-upgraded-gmrt-will-open-new-windows-on-the-universe-4678505/
Come 2018, upgraded GMRT will open new windows on the universe

3. The Indian Express, Pune, Anjali Marar, May 29, 2017
https://indianexpress.com/article/india/gmrt-leopards-interfering-mobile-signals-rail-line-that-threatens-to-go-through-it-4678503
GMRT: Leopards, interfering mobile signals, rail line that threatens to go through it

4. The Hindu, Chennai, Shubashree Desikan, October 17, 2017
https://www.thehindu.com/todays-paper/tp-national/observations-confirm-neutron-star-merger/article19874039.ece
Observations confirm neutron star merger

5. The Indian Express, Bengaluru, IANS, November 7, 2017
https://indianexpress.com/article/technology/science/isros-astrosat-telescope-measures-star-parameters-in-taurus-constellation-4926850/
ISRO's AstroSat telescope measures star parameters in Taurus constellation,

6. The Indian Express, Pune, Express News Service, November 7, 2017
https://indianexpress.com/article/india/published-in-nature-astronomy-astrosat-discovers- strange-polarisation-in-crab-nebula-pulsar-4925764/
Published in Nature Astronomy: AstroSat discovers 'strange' polarisation in Crab Nebula pulsar

7. a) Department of Astronomy, Stockholm University, December 20, 2017
https://www.astro.su.se/english/about-us/research-news/update-on-neutron-star-smash-up 363458
Update on Neutron Star Smash-Up: Jet Hit a Roadblock
b) Swedish version, Department of Astronomy, Stockholm University, December 21, 2017
https://www.astro.su.se/om-oss/nyheter/kvvd-jetstrle-frn-sammansmltand63465

8. The Indian Express, Pune, Express News Service, December 21, 2017
https://indianexpress.com/article/technology/science/signals-captured-by-gmrt help-detect-neutron-star-collisions-4992282/
Signals captured by GMRT help detect neutron star collisions

9. OutlookIndia, December 21, 2017
https://www.outlookindia.com/website/ story/how-indian-telescope-data-helped-solve-mystery-of-jets-from-colliding-ne 305819
How Indian Telescope Data Helped Solve Mystery Of Jets From Colliding Neutron Stars

10. Times of India, December 21, 2017
https://timesofindia.indiatimes.com/city/pune/radio-waves-from-neutron-star-merger-detected/articleshow/ 62185734.cms
Radio Waves from the neutron star merge detected

11. Indian Express, Express News Service, Pune December 21, 2017
http://indianexpress.com/article/technology/science/signals-captured-by-gmrt-help-detect-neutron-star-collision
Signals captured by GMRT help detect neutron star collisions

12. India Science Wire, DST, December 21, 2017
http://vigyanprasar.gov.in/ isw/colliding_neutron_stars_story.html
How Indian telescope data helped solve mystery of jets from colliding neutron stars

13. The Wire, Science, December 22, 2017
https://thewire.in/science/neutron-star-merger-study-uncovers-new-mystery-cocoon
Study of Neutron-Star Merger Uncovers New Mystery: The 'Cocoon'

14. The Indian Express, Pune Anjali Marar, March 6, 2018,
https://indianexpress.com/article/cities/pune/upgraded-gmrt-to-be-operational-in-april-says-ncras-new-director-5087559
Upgraded GMRT to be operational in April, says NCRA's new director