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Highlights from the observatories

Compiled by D.J. Saikia

Discovery of a candidate microlensing event using the 104-cm Sampurnanand optical telescope at ARIES, Nainital

The discovery of a candidate microlensing event and detection of 359 variable stars have been made by carrying out a photometric survey of $13' \times 13'$ field towards the galaxy M31 down to ~21 mag in the *R*-band using the 104-cm telescope at ARIES, Nainital.

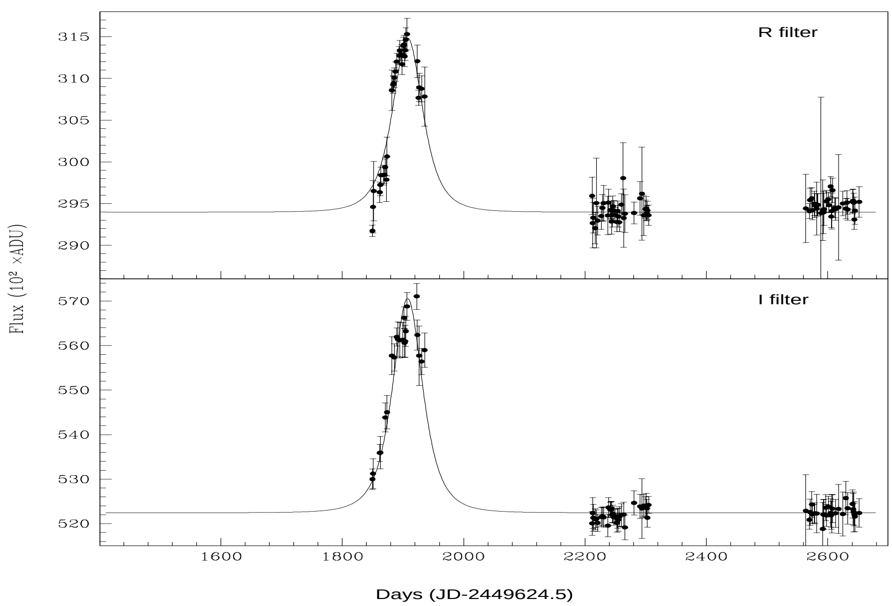

Figure 1. The *R* and *I* band pixel light curves of the first candidate microlensing event detected from Nainital. The continuous line represents the result of the Paczyński fit.

M31 has played an important role in understanding a wide variety of astrophysical problems. In recent years, it has been targeted to search for dark matter through microlensing of background stars against their foreground massive compact objects. The Nainital Microlensing Survey (NMS) being conducted since 1998 has resulted in detection of a microlensing candidate NMS-E1 by Y.C. Joshi of ARIES and TIFR, A.K. Pandey and Ram Sagar of ARIES and D. Narasimha of TIFR and Tohoku University, making it the first candidate event to be reported from India. The results are described in detail by Joshi et al. (2005). The candidate NMS-E1 lies in the disk of M31 at $\alpha_{2000} = 0^h43^m33^s.3$ and $\delta_{2000} = +41^o06'44''$, $\sim 15'.5$ to the South-East from the centre of M31. Figure 1 shows the R and I band pixel light curves of the microlensing candidate NMS-E1. The photometric analysis of the light curve shows that it reached a maximum of $R \sim 20.1$ mag, and colour $(R - I)_0$ of the lensed star was estimated as ~ 1.1 mag. The light curves indicate that the microlensing candidate is blended by red variable stars.

In addition to the microlensing event, extensive photometric survey of ~ 4000 stars down to ~ 21 mag in the R-band has led to the detection of 359 variable stars. Out of the 359 variables, 26 Cepheids are present in the region in which 2 are newly discovered, 11 are classified as Cepheids for the first time and 13 are confirmed as Cepheids. A distance modulus of 24.49 ± 0.11 mag for M31 was determined using the period-luminosity relation of Cepheids. Two novae events have also been detected from this survey.

GMRT detection of the afterglow from SGR 1806−20

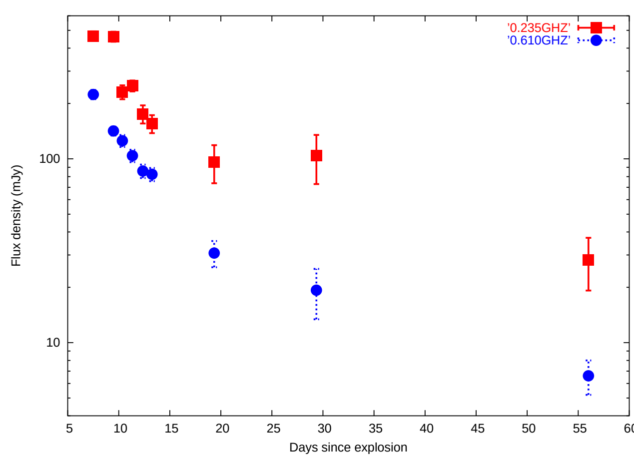

Figure 2. GMRT light curves of SGR 1806−20 in 235 and 610 MHz wavebands.

The soft gamma-ray repeater, SGR 1806−20, is a rare Galactic source, from which a giant flare with a fluence of 0.3 erg cm^{-2} was observed on 2004 Dec 27. This was one of the most energetic flares which usually takes place on time scales of about once in a century. The gamma-ray energy was so huge that it saturated all the sky-based gamma-ray detectors. The afterglow of SGR

1806−20 was observed in radio wave bands with the GMRT by Poonam Chandra and Alak Ray of the TIFR and their collaborators. This is the first radio afterglow detection of a soft gamma-ray repeater with GMRT. These and other observations of this interesting source have been presented recently by Cameron et al. (2005). The flux density of the SGR has been monitored from January 4th till date at 235 and 610 MHz wavebands with the GMRT. The last observations were made on 24th February. The GMRT observations are very crucial in determining the nature of the source at such low frequencies. The radio emission shows flattening of the light curve at later epochs, which seems to be coming from two populations of electrons. These authors suggest that the radio emission up to 2 weeks is from the shocked ejecta while the slowly decaying component afterwards is likely to arise from the forward-shocked shell as the ejecta hits the surrounding medium.

R−band variability of L dwarfs

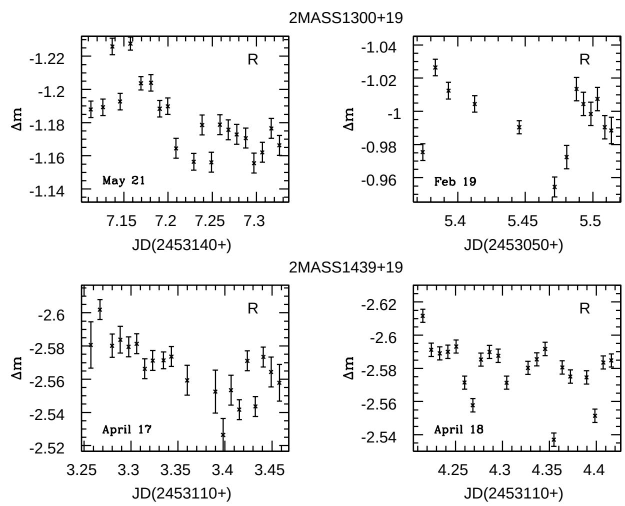

Figure 3. *R*−band light curves of the dwarfs 2MASS 1300+19 (upper panels) and 2MASS 1439+19 (lower panels) obtained on different nights.

L dwarfs are cool objects with temperatures in the range of 1400 to 2200 K, and are characterised by the presence of condensates in their atmospheres. Dust clouds in the atmospheres of L dwarfs could cause variability of these objects, and provide a useful probe of atmospheric activity. M. Maiti, S. Sengupta, P.S.Parihar and G.C. Anupama of the Indian Insitute of Astrophysics have monitored a small sample of L dwarfs with the 2-m Himalaya Chandra Telescope of the Indian Astronomical Observatory (IAO) at Hanle, using the Himalaya Faint Object Spectrograph Camera and have reported variability in the $R-$band for the first time (Maiti et al. 2005). Of the three L1 dwarfs, 2MASS 1300+19, 2MASS 1439+19 and 2MASS 1658+70, observed by them, they have reported the detection of variability in the first two with an amplitude ranging from 0.01 to 0.02 mag. The $R-$band light curves for these two objects are shown in Figure 3. There is no evidence of any periodic behaviour and they suggest that the observed $R-$band variability is most likely due to atmospheric dust activity.

First results with the VBT Echelle Spectrometer: the RV Tauri star CV Virginis

RV Tauri stars constitute an interesting and rather uncommon type of intrinsic variable stars. These are low-mass, late-type supergiant pulsators that show deep and shallow minima with periods ranging from 40 to 150 d. They exhibit large infrared excess, and are confined to a well-defined region in the IRAS 12-25 μm, 25-60 μm diagram. The evolutionary status is believed to be post-asymptotic giant branch (AGB) or at the end of the AGB phase. Although photospheric chemical composition could give clues to the evolutionary status, such studies have revealed abundance anomalies possibly related to sites of dust formation, dust-gas separation and accretion of winnowed gas. Many of the RV Tauri stars that exhibit abundance anomalies are in binaries.

Kameswara Rao and Bacham Reddy of the Indian Institute of Astrophysics have used the fibre-fed coudé echelle spectrometer (Rao et al. 2005) of the 2.3-m Vainu Bappu Telescope (VBT) to study one of the coolest stars, CE Virginis, suspected to be an RV Tauri type star. Abundance analyses have been presented and discussed for RV Tauri variables by, for example, Giridhar et al. (2000, and references therein). For CE Virginis, Rao & Reddy (2005) find no systematic depletion of elements with respect to the condensation temperature, but there appears to be a significant depletion of elements with respect to the first ionization potential of the element. Their derived Li abundance indicates production of Li in the star.

GMRT search for long-period pulsars: discovery of a new pulsar with a period of 318 ms

A search for long-period pulsars (i.e. pulsars with periods greater than 3 sec) in the north Galactic plane is currently in progress using the GMRT at 610 MHz by B.C. Joshi of NCRA, TIFR and A. G. Lyne, M. McLaughlin, M. Kramer, D. R. Lorimer, O. Hewitt and A. Faulkner of Jodrell Bank Observatory, England. A relatively low number of such pulsars were discovered in the previous surveys due to low sensitivity for these periodicities. It is important to find more such pulsars for constraining the pulsar emission mechanism and towards understanding the relationship between radio pulsars and high energy “magnetars”. The high sensitivity of GMRT along with the 0.7

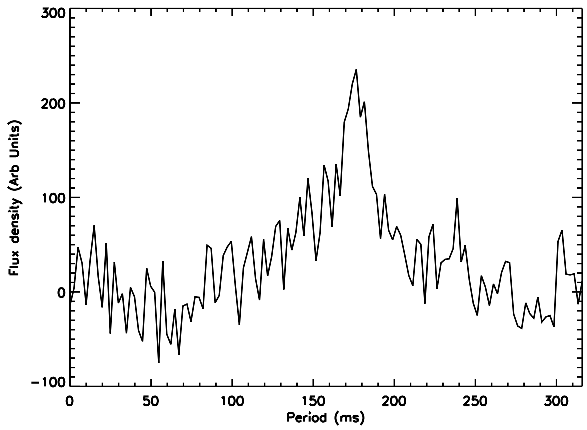

Figure 4. Pulse profile of the newly discovered pulsar J0026+6319 at 610 MHz obtained with the GMRT.

degree primary beam of the telescope and the low scatter broadening of pulsars at this frequency, make GMRT a very suitable instrument for this purpose.

During the course of this survey, a new pulsar, J0026+6319, with a period of 318 ms, was discovered in August 2004 (Fig. 4). The pulsar has a dispersion measure, DM, of 230 pc cm^{-3} and its timing observations suggest a period derivative less than 0.3×10^{-15}. An accurate position for the pulsar has also been obtained from the gridded observations at GMRT and the subsequent timing observations with Jodrell Bank Observatory. The survey has also resulted in several new pulsar candidates, which await confirmation from further observations with the GMRT.

HCT and GMRT study of the remnant of nova GK Persei

Cataclysmic Variables (CVs) are a diverse class of short-period, semi-detached binary systems consisting of a white dwarf primary accreting material from usually a low-mass, Roche-lobe filling, main-sequence companion star. The orbital periods of CVs range from ∼1.5 to 14 hr. The CVs are the progenitors of classical novae, which arise from explosive nuclear burning of the accreting material on the surface of the white dwarf. The outbursts result in ejection of $\sim10^{-4}$ $M_\odot$ of material with velocities up to a few thousand km s^{-1}. GK Persei is a classical nova system that had an outburst in 1901, and exhibits dwarf nova-like outbursts. G.C. Anupama of IIA and Nimisha Kantharia of NCRA, TIFR have observed GK Persei using both the HCT and GMRT to study the evolution of this well-known nova as it expands into the ambient medium. Using their data and available information in the literature they estimate the density of this medium to be ~0.12 cm^{-3} compared with ~0.8 cm^{-3} in 1987, and find evidence of a secular decrease in the radio flux density of ∼2.1 per cent at higher frequencies ($\gtrsim$1 GHz) but no such decrease at lower frequencies (Anupama & Kantharia 2005).

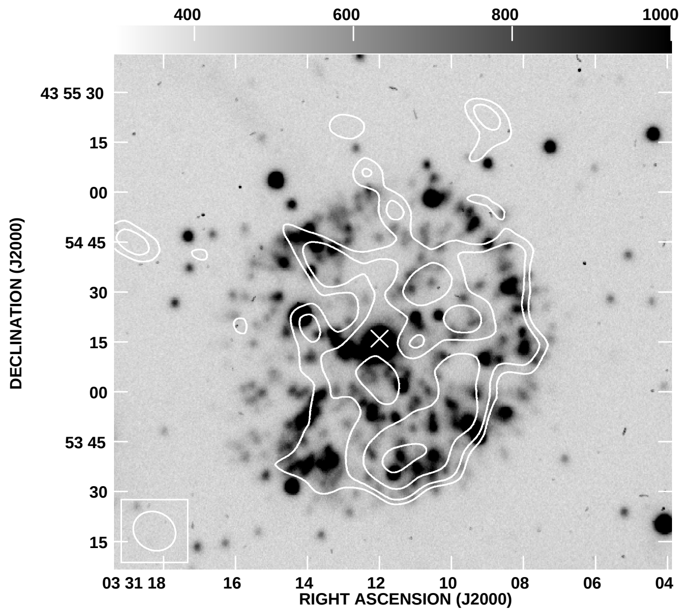

Figure 5. Radio emission contours at 0.33 GHz obtained with the GMRT are shown superimposed on a greyscale image of the remnant in Hα+[NII] obtained with the HCT.

Infrared observations of the nova-like variable V838 Monocerotis

V838 Monocerotis, the nova-like variable which erupted in February 2002, has been the subject of considerable studies at present. The object has shown several interesting features which are different from a classical nova viz. a multi-peaked outburst, a striking light-echo and a spectral evolution towards low temperatures. It appears that V838 Mon, and similar objects like V4332 Sgr and M31 RV, constitute a new class of eruptive variables (cf. Banerjee, Varricatt & Ashok 2004). The cause of the outburst in such objects is not completely understood. V838 Mon is being studied regularly in the near-IR JHK bands using the 1.2m Mt. Abu telescope by Dipankar Banerjee and Nagarhalli Ashok from PRL and their collaborators. Initial results have been presented by Banerjee & Ashok (2002). Some of their H band spectra, obtained between late 2002 to

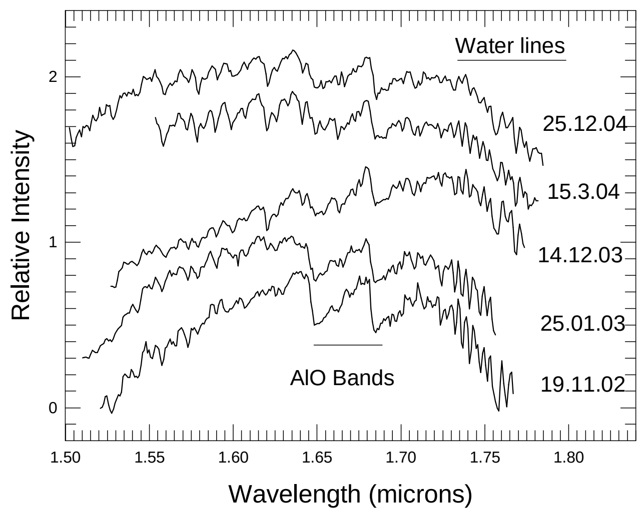

Figure 6. Near-infrared H band spectra of V838 Mon from the 1.2 meter telescope of the Mt. Abu Observatory. The epochs of observations are marked. Some of the spectral features are marked and discussed in the text.

recent spectra from late 2004, are shown in Figure 6. The notable features are the rare molecular bands of the A-X system of AlO at 1.648 and 1.6837 microns and several water lines which are seen in the 1.7−1.76 micron region. A detailed modeling of these spectroscopic features and also of the spectra in the J and K bands is being done to understand the evolution of the object.

A very extended gas disk in the dwarf irregular galaxy NGC 3741

Ayesha Begum and Jayaram Chengalur of NCRA, TIFR and I. Karachentsev of Special Astrophysical Observatory have presented GMRT HI 21cm images of a nearby dwarf irregular galaxy NGC 3741 ($M_B \sim -13.13$) which show it to have a gas disk that extends to ∼ 8.3 times its Holmberg radius. This makes it probably the most extended gas disk known. The observations allow them to derive the rotation curve (which is flat in the outer regions) out to ∼38 optical scale lengths. NGC 3741 has a dynamical mass to light ratio of ∼107 and is one of the "darkest" irregular galaxies known. However, the bulk of the baryonic mass in NGC 3741 is in the form of gas and the ratio of the dynamic mass to the baryonic mass (∼ 8), falls within the range that is typical for galaxies.

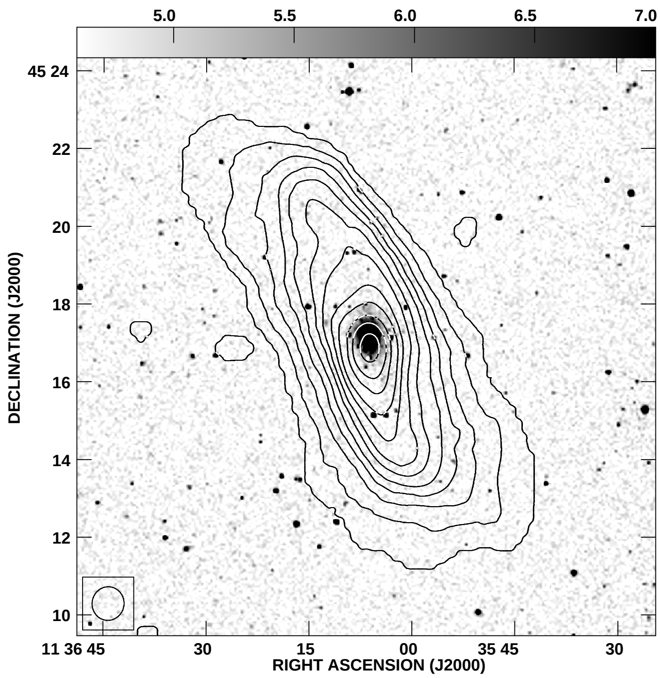

Figure 7. The B-band optical image of NGC 3741 (greyscales) with the GMRT 52″ × 49″ resolution integrated HI emission map (contours) overlayed. The contour levels are 0.1, 1.3, 2.6, 3.8, 5.0, 6.5, 7.8, 9.6, 11.3, 14.4, 17.0, 20.5 $\times 10^{20}$ atoms cm^{-2}

Gas-loss processes in disk galaxies

The gaseous interstellar medium (ISM) of disk galaxies are affected by various energetic and violent phenomena such as supernovae, stellar winds, jets driven by active galactic nuclei, winds from the accretion-disk and ram pressure stripping. Superwinds from starburst galaxies are important in supplying metal-enriched gas to the halo of the disk galaxy as well as to the intergalactic medium or the intracluster medium. This superwind outflow at the rate of 1−100 $M_\odot$/year and with a velocity of 300−1000 km s^{-1} is important for removing gas from the central regions of starburst galaxies. The jets also often contain enough energy to interact with the ISM clouds and drive them outwards. Another interesting process of gas removal is ram pressure stripping. Such processes are being studied for different samples with the GMRT in both radio continuum and HI by a number of groups. A few recent results are highlighted here.

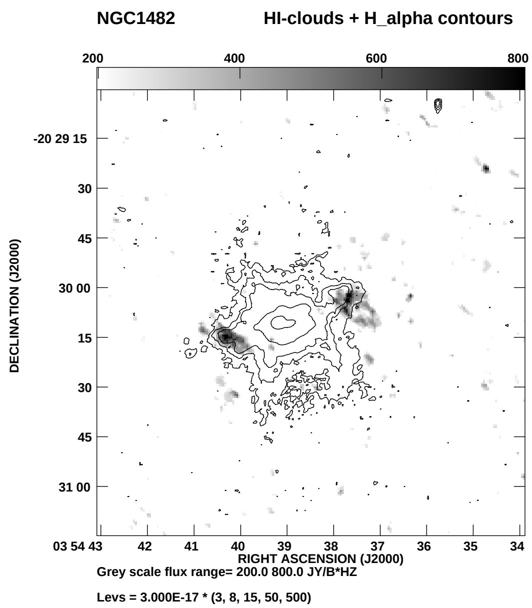

Figure 8. A GMRT HI total-intensity image of the superwind galaxy NGC1482 is shown in greyscale with an angular resolution of ∼6 arcsec. This is superimposed on an optical Hα image in contours which shows the remarkable hourglass-shaped optical emission-line outfbw (cf. Veilleux & Rupke 2002).

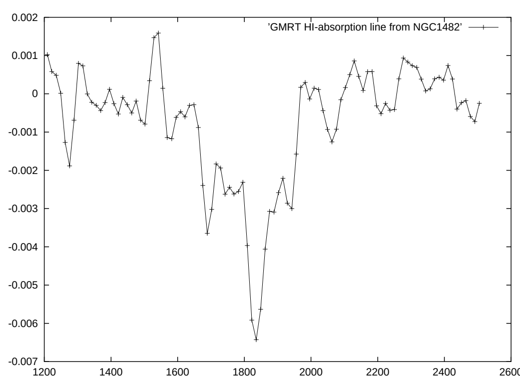

Figure 9. The GMRT HI absorption spectrum towards the central continuum source of NGC1482 with an angular resolution of ∼2 arcsec. The systemic velocity of the galaxy is 1850±20 km s^{-1}.

NGC1482: This is a nearby (24.7 Mpc) early type (S0/a) galaxy with a superwind outflow due to a starburst in the central region. GMRT HI-observations detect two blobs of HI in emission (Figure 8) rotating around the centre of the galaxy, while HI in absorption was detected against the central continuum source. The multi-component HI-absorption spectrum is ~250 km s^{-1} wide. The peak absorption is consistent with the systemic velocity of the object whereas the blue end is asymmetric by nearly 80 km s^{-1} (Figure 9), suggesting interaction of the outflowing gas with the ISM in the disk of the galaxy (Hota & Saikia 2005).

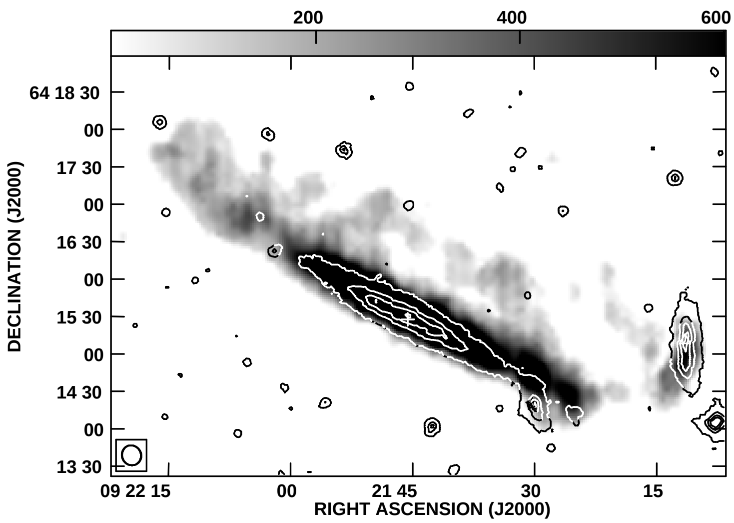

Figure 10. Greyscale GMRT image of the HI column density of the edge-on galaxy NGC2820 belonging to the group Holmberg 124 superimposed on the DSS optical map shown in contours. The HI extends well beyond the optical continuum and exhibits loops of emission towards the north-west.

NGC2820: This galaxy, which is a member of a poor group Holmberg 124, is strongly interacting with the companion NGC2814. The group has been studied using the GMRT by Nimisha Kantharia, S. Ananthakrishnan, Rajaram Nityananda and Ananda Hota of NCRA, TIFR. These observations show a radio-continuum bridge between the two strongly interacting galaxies. GMRT HI-observations reveal a huge HI-loop to the north-western side of the edge-on disk, extending ~4.9 kpc above the plane. The loop has a total HI-mass of $\sim 6\times10^8$ $M_\odot$. The sharp outer boundaries in the HI distributions of the two galaxies and the extra-planar loops have been interpreted to be due to the combined effects of ram pressure stripping and tidal interactions in the group (Kantharia et al. 2005).

NGC4438: This Virgo cluster galaxy has a distorted morphology due to its interaction with a companion. The radio continuum and HI observations have been made with the GMRT made by Ananda Hota and D.J. Saikia of NCRA, TIFR and Judith Irwin of Queen's University, Kingston. The continuum observations show the central emission, which has been studied earlier in detail with the Very Large Array by Hummel & Saikia (1991), as well as the faint diffuse emission to

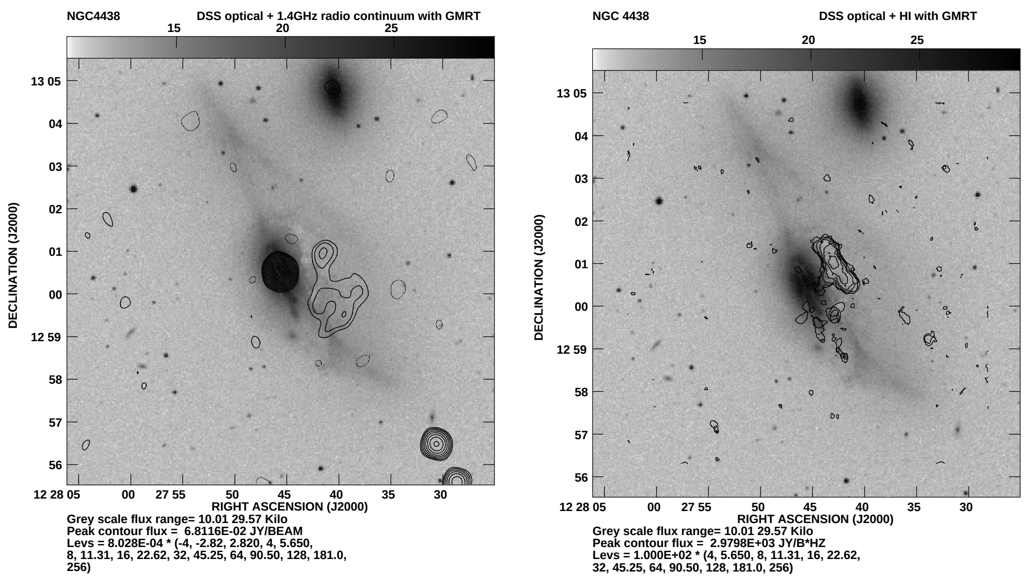

Figure 11. Left panel: The GMRT 1.4GHz radio continuum contour-map of the edge-on Seyfert galaxy NGC4438 in the Virgo cluster is superimposed on the DSS blue-band optical image shown in greyscale. Right panel: The GMRT total-intensity HI contour-map is superimposed on the DSS image.

the west of the main galaxy disk. The HI-observations with the GMRT show a linear structure in HI-emission residing on the same western side and ~5 kpc away from the main disk and roughly parallel to the nearly edge-on stellar disk. The mass of the linear HI-structure is nearly $2{\times}10^8$ $M_{\odot}$. Diffuse emission on the western side has also been seen in Hα and soft X-ray emission. One possible interpretation of such unusual morphology is ram pressure stripping with some contribution from the tidal-interactions.

Engineering first light from the IUCAA telescope

IUCAA is currently setting up an observatory with a 2m, f/10, Ritchey-Chretien Alt-Az. mounted telescope, at Girawali, a site which is about 90km from Pune at an altitude of about 1000m. The telescope achieved engineering first light stage on 10th December 2004. Over the last couple of months, engineers from Telescope Technologies Ltd. Liverpool UK (who manufactured the telescope) and IUCAA staff had been working on system integration and tuning of the telescope performance. Once system integration is completed, an extensive set of acceptance tests will be conducted, before the telescope is opened for use by the astronomy community.

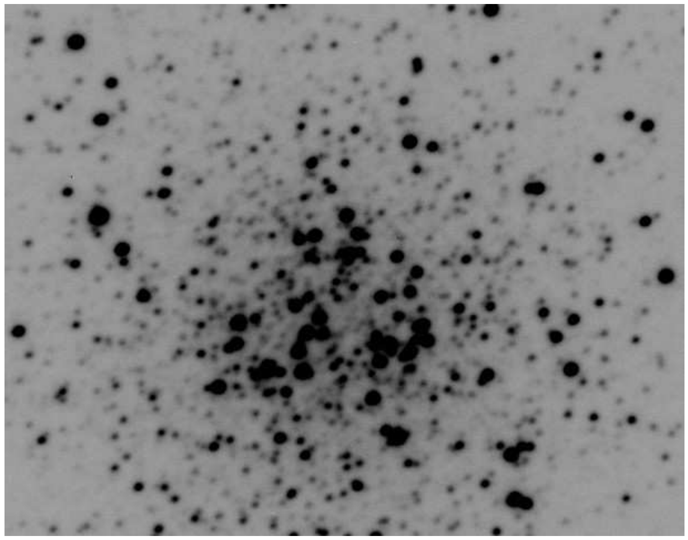

Figure 12. A 25-second exposure of Globular Cluster M53, taken with the autoguider CCD of the telescope deployed at the field centre. The image scale is about 0.22 arcseconds per pixel and the stellar PSFs have typical FWHM of about 1.2 arcseconds.

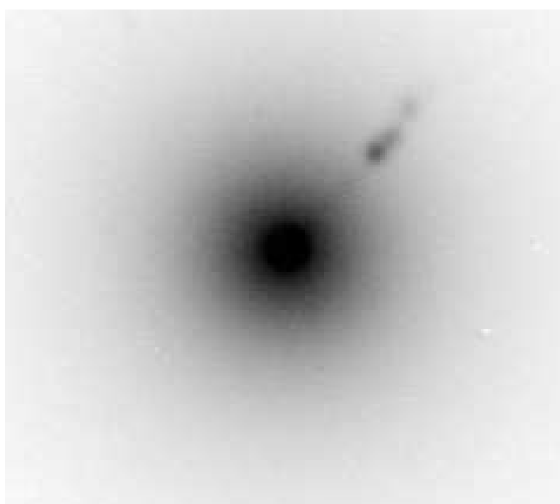

Figure 13. The giant elliptical galaxy, M87, in Virgo. This 240 second exposure clearly shows the knots in the optical jet (of about 8000 lightyear total size) from the centre of the galaxy, which is about 60 million lightyears away.

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