NATIONAL RADIO ASTRONOMY OBSERVATORY

Newsletter

April 2008

Issue 115

The Expansion of Supernova Remnant G21.5–0.9: Is PSR J1833–1034 the Youngest Pulsar?

Cosmic Rays and the Magnetic Field in the Nearby Starburst Galaxy NGC 253

The Birth and Feedback of Massive Stars, Within and Beyond the Galaxy: The NAASC Science Workshop for 2008

ALMA and EVLA Project Progress

Also in this Issue:

Neutral Hydrogen Clouds in the M81/M82 Group

Discovery of a Small Group Driving the Evolution of an Edge-On Spiral Galaxy

New NRAO Website Debuts

First 3mm Science Observations with the GBT and MUSTANG Call for Proposals

Eleventh Synthesis Imaging Workshop

2008 Grote Reber Medal Awarded to Sandy Weinreb

Table of Contents

Science **1**

The Expansion of Supernova Remnant G21.5–0.9: Is PSR J1833–1034 the Youngest Pulsar? 1
Discovery of a Small Group Driving the Evolution of an Edge-On Spiral Galaxy 2
Cosmic Rays and the Magnetic Field in the Nearby Starburst Galaxy NGC 253 5
Neutral Hydrogen Clouds in the M81/M82 Group 7

ALMA **9**

ALMA Project Progress 9
North American ALMA Science Center 11
The ALMA Spectral Line Catalog 12
The Birth and Feedback of Massive Stars, Within and Beyond the Galaxy: The NAASC Science Workshop for 2008 12

EVLA **14**

Current Status 14

Socorro **16**

VLA Configuration Schedule 16
VLA Proposals 16
VLA Scheduling 16
VLBA and HSA Proposals 17
VLBA and HSA Scheduling 17
Global cm VLBI Proposals 17
VLA and EVLA Spectral Line Observations Below 1200 MHz 17
Status of Observing with the Transition Array 19
VLBA Sensitivity Upgrade Project 20

Green Bank **21**

First 3mm Science Observations with the GBT and MUSTANG Call for Proposals 21
The GBT Dynamic Scheduling System Update 23
Progress on the Ka-Band Focal Plane Array for the GBT 23
Opportunities for University-Led Technical Development Projects in Green Bank 24

Education and Public Outreach **25**

New NRAO Website Debuts 25
The NRAO at the American Astronomical Society and American Association for the Advancement of Science Meetings 26

In General **28**

Call for GBT Shared-Risk MUSTANG Proposals 28
Large Proposals to Use NRAO Telescopes 28
Chris Carilli Appointed Observatory Chief Scientist 29
Eleventh Synthesis Imaging Workshop 29
2008 Grote Reber Medal Awarded to Sandy Weinreb 29
NRAO Participates in the BEYA Conference 30
NRAO Business Managers Meet in Chile 31
NRAO Library News 32

Cover: Radio imaging with the Very Large Array captures newborn massive star clusters as they emerge from their birth material in the galaxy NGC 4449. These "super star clusters" contain tens to hundreds of thousands of stars. The young stars produce hot ionized gas which is detectable at radio wavelengths, shown in blue here. An image from the Hubble Space Telescope shows the visible starlight in yellow.

Investigator(s): Amy Reines (University of Virginia), Kelsey Johnson (University of Virginia/NRAO), and Miller Goss (NRAO).

Science

The Expansion of Supernova Remnant G21.5–0.9: Is PSR J1833–1034 the Youngest Pulsar?

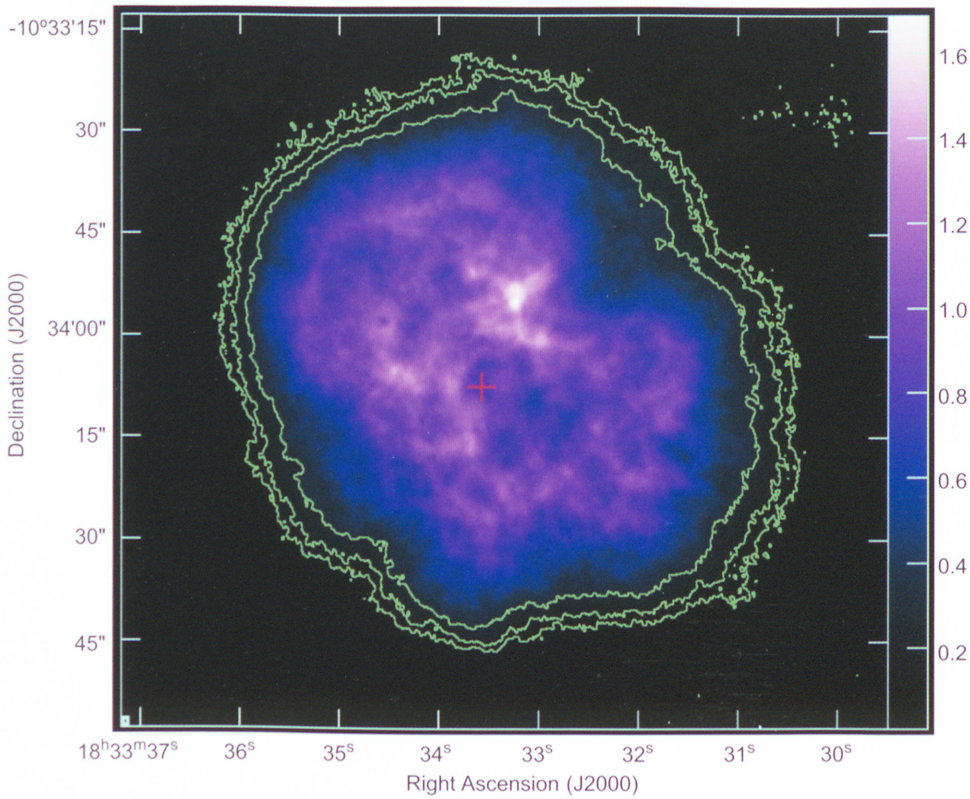


Figure 1. A radio image of G21.5–0.9 at 4.75 GHz from 2006. Maximum entropy deconvolution was used. The FWHM of the elliptical Gaussian restoring beam was 0.82 × 0.53" at p.a. 10 degrees. The peak brightness was 1.69 mJy bm^{-1} and the rms background brightness was 19 μJy bm^{-1}. Contours are drawn at 4, 8, and 16 percent of the peak brightness. The red cross marks the position of the pulsar, taken from Camilo et al. (2006), and known to an accuracy of < 0.5". Filamentary structure can be seen throughout the nebula.

The supernova remnant G21.5–0.9 (SNR 021.5–00.9) has been known for over 30 years and has long been classified as a filled-center or a Crab-like remnant (e.g., Wilson & Weiler 1976). Such supernova remnants are powered by a central pulsar rather than by the interaction of the expanding ejecta shell with its surroundings. This is known as a "pulsar wind nebula" or PWN, with the Crab Nebula generally being regarded as the prototype. G21.5–0.9 is a bright, centrally condensed radio and X-ray source, with a diameter of ~1", although in the X-ray, a larger, low surface brightness halo is also seen (Bocchino et al. 2005; Matheson & Safi-Harb 2005). The distance to G21.5–0.9 is ~5 kpc (Camilo et al. 2006). G21.5–0.9's radio and X-ray luminosities are ~10 percent and ~1 percent of those, respectively, of the Crab Nebula.

Although G21.5–0.9 had been identified as a PWN, no pulsar had been seen until recently, when two teams announced the discovery of PSR J1833–1034 (Gupta et al. 2005; Camilo et al. 2006), with a period of 61.8 ms. Although the pulsar is quite faint (~70 μJy at 1.4 GHz), it is slowing down rapidly, and has a spindown energy loss of ~3.3×10^{37} erg s^{-1}, which, in our Galaxy, is second only to that of the Crab pulsar.

The characteristic age of the pulsar is 4800 yr. However, the characteristic ages are often very inaccurate measures of pulsars' true ages, and no other direct age measurements were so far available for PSR J1833–1034 or G21.5–0.9. The latter's relatively small size and other arguments had led several authors to suggest a notably younger true age of ~1000 yr (e.g., Bocchino et al. 2005; Camilo et al. 2006).

We obtained a new, high-resolution image of G21.5–0.9 in 2006 using the NRAO VLA at 5 GHz in the A and B array configurations. We also used some D-configuration data from the VLA archive to better recover the large-scale structure of the nebula (see Bietenholz & Bartel 2008).

We show our image of G21.5–0.9 in Figure 1. Prominent filamentary structure is seen, reminiscent of that seen in radio images of the Crab Nebula and 3C 58. Such filamentary structure seems to be a common feature of PWNe. The remnant has a double-lobed structure, with the axis of symmetry running approximately from the northwest to the southeast, similar to the structure seen in the X-ray. Unlike in the X-ray, however, there is no bright central condensation in the radio, and the northwest lobe is somewhat brighter than the southeast one.

We also re-imaged archival VLA data from 1991 (Frail & Moffett 1993) to produce a 1.5 GHz image. By comparing the two images, taken almost 15 years apart, we determined the expansion speed of the nebula. We also determined the spectral index, which is quite uniform over the nebula, as is typical of PWNe. (For details of how the spectral index and temporal evolution were disentangled, see Bietenholz & Bartel 2008).

G21.5–0.9 has expanded by 1.7 ± 0.3 percent over the 14.8 yr period between the two images. At 5 kpc, this corresponds to an expansion speed of 910 ± 160 km s^{-1} with respect to the center of the nebula. Assuming undecelerated expansion, this speed implies that the age of G21.5–0.9, and thus also of PSR J1833–1034, is 870^{+200}_{-150} yr, dramatically confirming earlier suggestions of a young age. This age makes PSR J1833–1034 and G21.5–0.9 one of the youngest known pulsars and PWNe. Although the expansion age is a far more reliable estimate of the true age than the pulsar's characteristic age, it is likely a slight underestimate. Since the PWN is expanding not within a stationary medium, but within the more rapidly expanding supernova ejecta, the pulsar's energy input will cause a small acceleration, making the true age slightly less than our expansion age. The Crab Nebula's true age is known, as it is associated with a recorded supernova in 1054 AD, and its expansion age is ~800 yr.

In other words, our measurement suggests that G21.5–0.9 and the Crab Nebula likely have similar true ages of ~1000 yr. We note that the hydrogen column density and visual extinction (10–11 mag) implied by the X-ray measurements makes it unlikely that the supernova event would have been noticed.

G21.5–0.9 and PSR J1833–1034 thus take their place among the youngest pulsars and pulsar-wind nebulae in the galaxy. Future observations may allow us to measure the acceleration, and thus directly measure the dynamics of a pulsar-wind nebula expanding into the shell of supernova ejecta.

M. F. Bietenholz
(Hartebeesthoek Radio Observatory, York University)

References:

Bietenholz, M. F., & Bartel, N. 2008, ArXiv e-prints, 0802.0152

Bocchino, F., van der Swaluw, E., Chevalier, R., & Bandiera, R. 2005, A&A, 442, 539

Camilo, F., Ransom, S. M., Gaensler, B. M., Slane, P. O., Lorimer, D. R., Reynolds, J., Manchester, R. N., & Murray, S. S. 2006, ApJ, 637, 456

Frail, D. A., & Moffett, D. A. 1993, ApJ, 408, 637

Gupta, Y., Mitra, D., Green, D. A., & Acharyya, A. 2005, Current Science, 89, 853

Matheson, H., & Safi-Harb, S. 2005, Advances in Space Research, 35, 1099

Wilson, A. S., & Weiler, K. W. 1976, A&A, 49, 357

Discovery of a Small Group Driving the Evolution of an Edge-On Spiral Galaxy

UGC 10043 is an edge-on, spiral galaxy located ~32 Mpc from us that was found to have several morphological peculiarities by Matthews & de Grijs (2004). In particular, optical images show that the bulge of UGC 10043 is elongated perpendicular to the major axis of the galaxy, and is bisected on its southwest quadrant by a dust lane parallel to the minor axis. Additionally, there are signs of a large-scale galactic

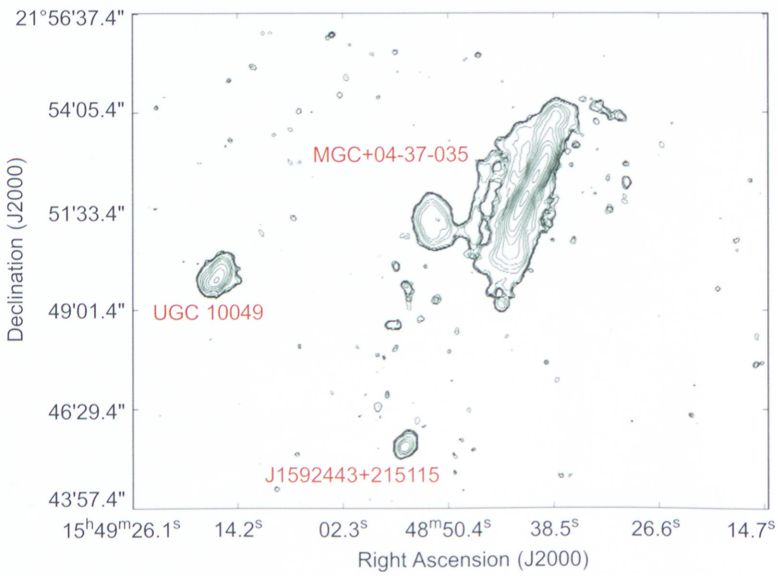


Figure 1. Integrated HI flux map. Contours plotted are 5.823×10^{-1} (0.3,0.5,1,1.4,2,2.0,4,5.6,8,11,16,22,32,44,64,88,100) Jy bm^{-1}.

wind, probably powered by a faint central starburst. The stellar disk is thin, dusty, and dynamically cold.

Such structural complexities relate UGC 10043 to relatively rare objects like orthogonally decoupled bulge systems (Bertola, 1999) and polar ring galaxies (Whitmore et al., 1990), all of which exhibit components with angular momentum parallel to the galaxy's major axis. Orthogonal rotation indicates a peculiar formation history that must have included a significant "second event" like a merger or accretion, which can play a key role in the evolution of massive galaxies. In the case of UGC 10043, Matthews & de Gris (2004) proposed three plausible formation scenarios: accretion of gas around a pre-existing spheroid (*Dressing a Naked Spheroid*), acquisition of a bulge after the disk had already formed and settled (*Capture*), and simultaneous formation of disk and bulge through the merger of two moderate-size galaxies.

Our goal is to gain further insight into the structure and kinematics of gas in UGC 10043 so as to constrain its history and discriminate between possible evolutionary models, which will allow us in turn to understand how the outcome of second events are affected by the properties of participating galaxies. We therefore observed UGC10043 with the VLA in HI spectral imaging mode, using the C and D configurations. Our results were presented at the 211th AAS Meeting (Aguirre, Uson & Matthews 2007).

The VLA data were reduced using standard AIPS routines and the squint-correcting algorithm (Uson & Cotton 2008) available in the *Obit* software package (Cotton 2007), from which we obtained channel images and moment maps. For UGC 10043 we measured a total flux of 22.19±0.14 Jy km s^{-1}, in good agreement with previous observations (Giovanelli, Avera & Karanchentsev 1997). We also detected emission from three neighboring galaxies, MGC+04-37-035, UGC 10049, and J1592443+215115, which reveals a small group environment as seen in Figure 1. UGC 10043 and MGC+04-37-035 are physically connected by a continuous gas bridge that runs parallel to the major axis of the galaxy and falls on top of the bulge of UGC 10043, close to the location of the minor axis dust lane. The gaseous disk of UGC 10043 extends ~3 times further than the optical component, and displays an integral-sign warp that could originate from interaction with MGC+04-37-035, since it has been shown that warps can be excited by infalling satellites (Huang & Carlberg 1997, Velázquez & White 1999). We also detect radio continuum emission in UGC 10043 that is consistent with a central star-formation origin according to the radio continuum/ IR relationship (Condon et al., 2002) and with the lack of a nuclear source in 4.9 and 8.4 GHz observations (Hummel et al., 1993, and VLA Archive Data).

To analyze the system's kinematics, we produced the map of the first moment shown in Figure 2. For UGC 10043, the velocity field shows the typical structure of a differentially rotating disk with angular momentum oriented along the south-west direction, smooth velocity transitions and V-shaped isovelocity contours. In the case of MGC+04-37-035, there are also signs of a rotating disk but the isovelocity contours are less pronounced due to its lower inclination angle and, most important, the rotation direction is

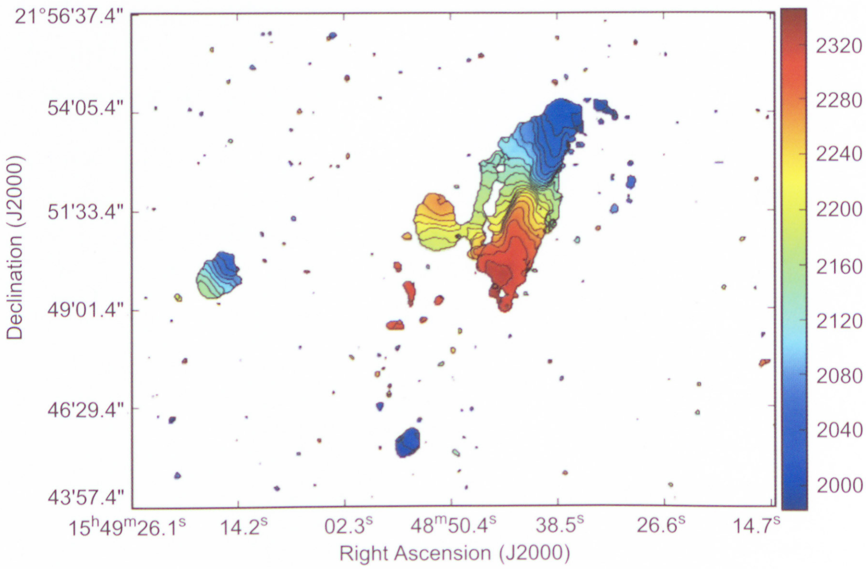


Figure 1. HI velocity field for UGC 10043. Contours are plotted over a linear color map of the velocity field map, ranging from 1956.92 to 2364.98 km s^{-1}, with a separation of 15.6 km s^{-1}. This is equivalent to plotting one of every two channels. The colorbar shows values of velocities in units of km s^{-1}.

opposed to that of UGC 10043. The velocity transition along the connecting gas bridge is very smooth, reinforcing the idea of a physical association. The fact that they are counterrotating is an important factor in the analysis of the interaction, because it determines how strongly the encounter affects them. We also detect a collection of small HI clouds forming arcs at the NW edge of UGC 10043 and SE border of MGC+04-37-035, which appear to trace an open orbit.

We built rotation curves for both galaxies using the "terminal velocity method" (Shane & Biegert-Smith, 1966), and derived their dynamical parameters. For UGC 10043 we obtain a systemic velocity of 2162.4±1 km s^{-1}, in good agreement with published results (Matthews & de Grijs 2004, Springob et al. 2005), and a maximum relative velocity of 163 km s^{-1}. For MGC+04-37-035, the maximum velocity is ~100 km s^{-1}, which translates into a dynamical equilibrium mass of ~$2.5\times10^{10}M_{\odot}$. This value is 100 times larger that the measured HI mass, so even if we accounted for the stellar and dust components the assumption of equilibrium would require MGC+04-37-035 to be more dark-matter dominated than most known galaxies. In turn, it is more likely that MGC+04-37-035 is perturbed and excited by the interaction with UGC 10043, which probably affected its spiral structure and accounts for its irregular flocculent appearance, with bright star-forming knots and rudimentary spiral arms (Matthews & de Grijs, 2004).

Regarding UGC 10043's morphological peculiarities, the smoothness in the velocity field shows no multi-spin components in the HI structure of UGC 10043, and no signs of a classic polar ring. We see no bowl-shaped structures around the bulge region either, as expected if the galaxy had captured a pre-existing spheroid.

Our HI observations reveal that UGC 10043 is affected by an ongoing interaction with MGC+04-37-035, which may account for some of the morphological peculiarities described by Matthews & de Grijs (2004). First, the gas tidally stripped from MGC+04-37-035 is being dumped onto the central region of UGC 10043, so it can therefore be related to the minor axis dust lane and would also help fuel the central starburst that powers the large scale galactic wind and radio continuum emission. The interaction is also consistent with the excitation of a warp in the gaseous disk, and the fact that the galaxies are counterrotating is compatible with the thin and dynamically cold stellar disk, because N-body simulations have shown that disks are less heated in retrograde encounters (Velázquez & White, 1999).

The complex configuration revealed by HI data reinforces the conclusion that UGC 10043 has had a peculiar formation history, and the new data can help us discriminate between models. The first scenario proposed by Matthews & de Grijs, *Dressing a Naked Spheroid,* could be supported by the ongoing accretion of gas from MGC+04-37-035, but this galaxy lacks enough mass to account for the whole disk of

UGC 10043. An alternative is the capture of a small, gas-poor elliptical, but this mechanism would produce bowl-shaped or ring structures around the bulge region (Matthews & de Grijs, 2004), which are not noticeable in our maps. Finally, a *major merger* in the past cannot be discarded, and in fact it is likely that the current interaction is actually a "third event" that is adding material to a pre-existing prolate bulge made of old, red stars.

Numerical simulations are needed to derive a precise interaction model, but the encounter seems to resemble the case of M51, the Whirlpool Galaxy, seen edge on. Our VLA HI data have revealed an unexpected picture for UGC 10043, in which its morphological characteristics must depend not only on its formation mechanism, but are also defined by its local environment and by the past (or ongoing) interactions that have driven its evolution.

This work was done as part of NRAO's summer *Graduate Student Research Assistantship Program*. I am grateful for the support of the staff at NRAO Charlottesville with special thanks to Juan Uson for his mentoring and guidance with this project. This work was also made possible by the collaboration and valuable suggestions of Lynn D. Matthews.

Paula Aquirre
(Pontificia Universidad Católica de Chile)

References:

Aguirre, P. A., Uson, J. M., & Matthews, L. D., 2007, BAAS, 39, 755

Bertola, F. et al, 1999, ApJ, 519, L127.

Condon, J. J., Cotton, W. D., Greisen, E. W., Yin, Q. F., Perley, R. A., Taylor, G. B., & Broderick, J. J. 1998, AJ, 115, 1693

Cotton, W.D., 2007, PASP (submitted)

Giovanelli, R., Avera, E. & Karanchentsev, I.D., 1997, Astron.J. 114, 122.

Huang, S. & Carlberg, R.G., 2004, AJ, 128, 137.

Matthews,L.D & de Grijs,R., 2004, AJ, 128, 137

Shane, W.W, & Bieger-Smith, G.P., 1966, Bull. Astron. Inst. Netherlands, 18,263

Springob, C. M., Haynes, M. Giovanelli, R. & Kent, B., 2005, ApJS, 160, 149.

Uson, J. M. & Cotton, W. D., 2008, A & A (submitted).

Velázquez,H. and White,S.D.M, 1999, MNRAS, 304, 254.

Whitmore, B.C., Lucas, R.A., McElroy, D.B., Steiman-Cameron, T.Y., Sackett, P.D. & Olling, R.P., 1990, AJ, 100, 1489.

Cosmic Rays and the Magnetic Field in the Nearby Starburst Galaxy NGC 253

The interaction between the cosmic ray distribution, the structure of the large-scale magnetic field, and features of the interstellar medium (ISM) can be best investigated in edge-on galaxies, where the geometry is well known. Cosmic rays (CRs) are accelerated in the disk by supernova shock waves and are transported from the disk into the halo while losing their energy due to synchrotron radiation. This is visible in the spectral index which is rather flat in the disk but steepens with increasing distance from the disk, indicating an aged CR population in the halo. However, the interaction between a galactic wind, the cosmic rays, and the magnetic field is not yet understood. A possible scenario is that the cosmic rays and the magnetic field are advected in the galactic wind and thereby trace both the bulk speed of the wind and its direction. NGC 253 is a favorite object to study such a scenario since it hosts one of the brightest known radio halos, allowing radio continuum observations, including linear polarization, with both high sensitivity and spatial resolution. Moreover, it is known to possess a galactic wind visible as an outflow of hot Hα and X-ray emitting gas.

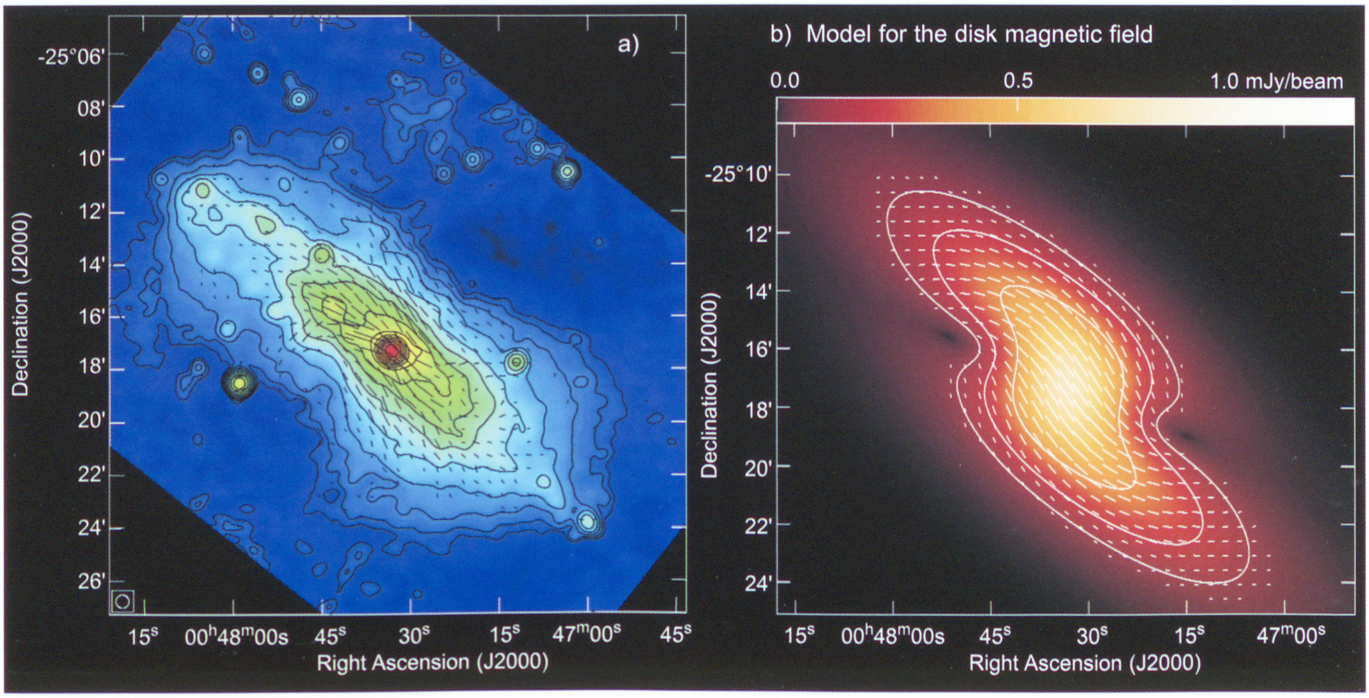


Figure 1. a) Total power radio continuum image obtained from combined VLA+ Effelsberg observations at λ 6.2 cm. The overlaid vectors indicate the orientation of the intrinsic ordered magnetic field. The length of the vectors is 1 arcsec per 12.5 μJy bm^{-1} of polarized intensity. Contours are at 3, 6, 12, 24, 48, 96, 192, 384, 768, 1536, 3077, 6144, 12288, and 24576 × 30 μJy bm^{-1}. b) Axisymmetric model for the disk (toroidal) magnetic field with a pitch angle of 25° of the magnetic field spiral. Contours are at 3, 6, 12, and 24× 30μ Jy bm^{-1}. The overlaid vectors indicate the orientation of the intrinsic regular magnetic field. The length of the vectors is 1 arcsec per 12.5 μJy bm^{-1} of polarized intensity.

The observational challenge in observing NGC 253 with the VLA is to properly separate the strong (≈1 Jy) nuclear continuum point source from the extended emission. For the total power emission this can be effectively done using self-calibration which in our case resulted in a signal-to-noise ratio S/N of 40,000. However, for polarization self-calibration it is not sufficient. In our VLA mosaic of NGC 253 some pointings contain the nuclear point source at an off-axis location, and so the instrumental polarization is very high (up to a few percent with respect to the total power). The sidelobes of the instrumental polarization cannot be removed using CLEAN since they are time variable as the nucleus rotates around the center because of the changing parallactic angle. We therefore used a new polarization calibration scheme, subtracting the nuclear point source from the (u,v) data prior to making the image. Moreover, the polarization calibration was made for the nucleus itself to derive the instrumental polarization for the off-axis positions of the nucleus in the primary beam. We were able to produce polarization maps which are almost free of instrumental polarization. Finally, we combined observations of the 100 m Effelsberg telescope with the VLA interferometric observations to fill up the missing zero-spacing flux since we are mainly interested in the extended structures. This is particularly important since the negative bowl from the missing zero spacings causes an extra-planar depression just outside of the disk, effectively hiding any extra-planar emission.

The total power radio continuum emission along with the orientation of the large-scale magnetic field is presented in Figure 1a. The contour lines show dumb-bell-shaped extra-planar emission, with the smallest vertical extent found at small galactocentric radii. This has been confirmed by fitting a two-component exponential function to the vertical emission. The scale height of the synchrotron emission shows a linear dependence on the local synchrotron lifetime of the

CR electrons. Therefore, the CR transport must proceed preferentially in the vertical direction from the disk into the halo.

This "disk wind" can interact with the large-scale magnetic field. The polarization map shows a magnetic field with an "X"-shaped pattern. Only for small distances to the galactic midplane and for small galactocentric radii is the orientation of the magnetic field plane-parallel. Southeast of the nucleus the vertical magnetic field component is significant, displaying a "radio spur". However, as the inclination of the galaxy is not exactly edge-on, we still see a significant contribution from the magnetic field in the disk. A model for the disk (toroidal) magnetic field was made where a spiral magnetic field with a constant pitch angle—as suggested by the analysis of the rotation measure—was assumed (Figure 1b). Subtracting the disk magnetic field from the observed magnetic field reveals the halo (poloidal) magnetic field which shows a distinct "X"-shape, centered on the nucleus (Figure 2). The magnetic field is roughly tangential to the superbubbles seen in soft X-ray emission. The enhancement of the ordered magnetic field at the boundaries of the bubbles can be explained by the expansion of the superbubble which heats the surrounding gas (seen as neutral hydrogen) where the hot gas is visible as Hα and X-ray emitting gas. Hence our observations suggest that there is a lateral pressure gradient in the halo which enhances the halo magnetic field by compression due to the expanding superbubble. The kinetic energy of the disk wind would be high enough to escape from the gravitational potential, however we trace only the lower part of the halo ($z<4$ kpc) and hence a definite statement cannot be made.

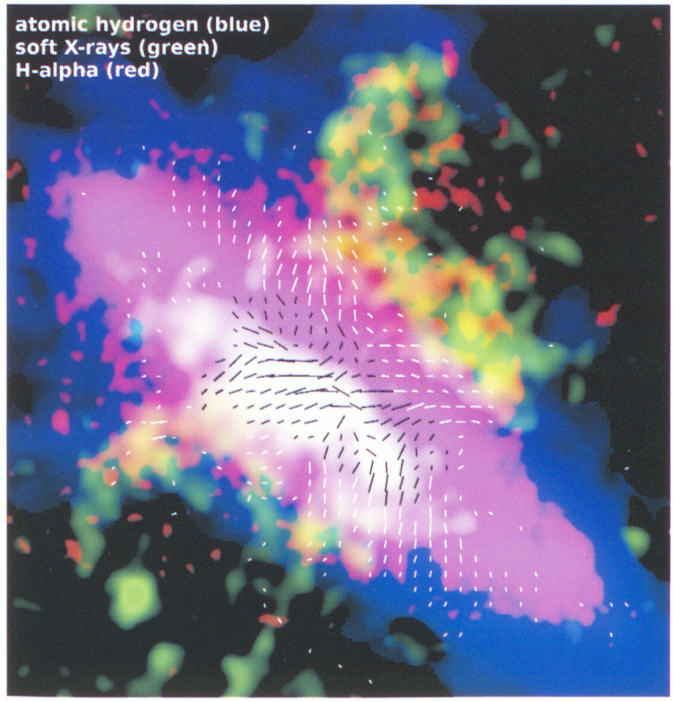


Figure 2. Orientation of the halo (poloidal) magnetic field overlaid on atomic hydrogen (Boomsma et al. 2005), ionized hydrogen (Hoopes et al. 1996) and soft X-ray emission (ROSAT PSPC) images.

To study the transition between the halo and the intergalactic medium future low-frequency observations could be used where the scale height of the synchrotron emission is much larger. The EVLA and the SKA are the best suitable instruments since for LOFAR the declination of NGC 253 (-25°) is too low.

V. Heesen (University of Bochum, Germany), R. Beck, M. Krause (Max Planck Institute for Radioastronomy, Germany), and R. J. Dettmar (University of Bochum, Germany)

Neutral Hydrogen Clouds in the M81/M82 Group

High Velocity Clouds (HVCs) of neutral hydrogen are common in the sky around the Milky Way and may result from a variety of phenomena, including primordial infall, a galactic fountain, and interaction with satellites. These processes are fundamental to the origin and evolution of the Milky Way and other galaxies, so HVCs have received increasing scrutiny in recent years. The physical qualities of the clouds, such as their mass and density, require knowledge of their distance. For Milky Way HVCs, this is particularly difficult to measure. To circumvent this problem, and to place Galactic HVCs in a larger astrophysical context, it is useful to search for HVC analogs in other galaxies whose distances are known. Previous studies have found HI structures around many galaxies, including M31 (Thilker et al. 2004) which may be related to the HVC phenomenon.

We used the Green Bank Telescope to observe HI over a $3° \times 3°$ area centered on the M81/M82 galaxy group, a gas-rich system of more than a dozen galaxies with clear signs of tidal interaction. The GBT's sensitivity to extended, low surface-brightness emission gave our maps a 7σ detection limit of 9.6×10^5 $M_\odot$ per beam in a single spectral channel, the lowest surface-brightness threshold of any extragalactic HVC survey to date. Spectral maps in the velocity range of interest were inspected for objects that were spatially distinct from group galaxies and tidal streams, and well-confined kinematically. We detected five previously unknown HI clouds associated with the group.

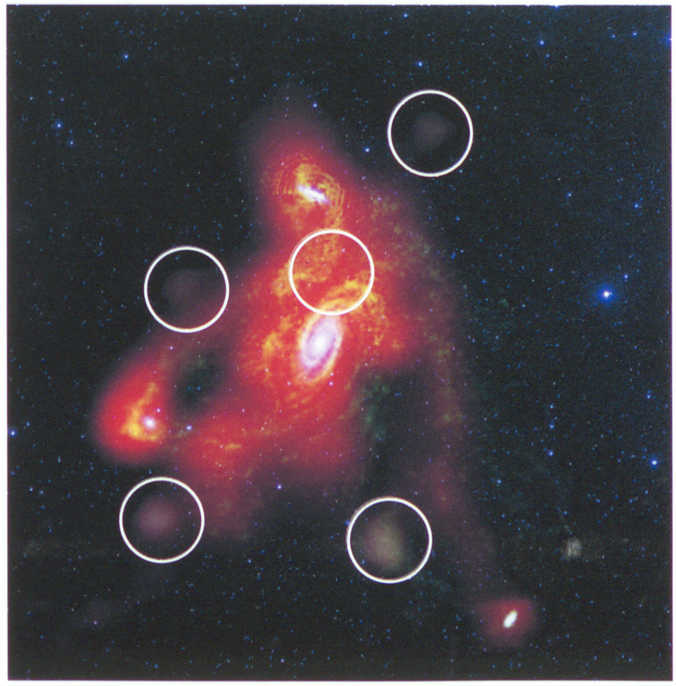


Figure 1. Composite radio and optical image of the M81/M82 galaxy group. Orange: GBT HI column density map from Chynoweth et al (2008). New HI cloud detections are circled and highlighted in white. Yellow: VLA HI column density from Yun et al (1994). Both column density maps are integrated from -250 to 340 km s^{-1}. Blue: Optical image from DSS. (Image credit: Chynoweth, Langston, Saxton, NRAO).

The observations are shown in Figure 1, with the new clouds highlighted. Interestingly, all new HI clouds are located at small angular separation from group members, and at small velocity differences from group members. We find clouds only within 35 kpc and 120 km s^{-1} of associated galaxies. The new HI clouds have masses ranging from 0.69 to 8.37×10^7 $M_\odot$, similar to clouds detected around the Milky Way (Wakker & van Woerden 1997) and larger than the clouds detected in M31 (Thilker et al. 2004). These results are described in detail in Chynoweth et al. (2008).

Based upon the proximity of the clouds to group galaxies in position and velocity, we conclude that the clouds are most likely relics of ongoing interactions between galaxies in the group. Our results are inconsistent with models of primordial HI cloud infall. We plan to extend our work to other nearby groups.

We are currently performing detailed numerical simulations of the mass distribution and trajectories of the galaxies and newly detected clouds in the M81 group. These simulations improve upon the previous work of Yun (1999) by utilizing a fully self-consistent N-body model of the galaxy group, with particular emphasis on reproducing the isolated HI structures observed. The ultimate goal of this work is to understand the origin and evolution of extragalactic HI clouds, and their relationship to the HVCs in the Milky Way.

K. M. Chynoweth, K. Holley-Bockelmann (Vanderbilt University), G. I. Langston and F. J. Lockman (NRAO)

References:

Chynoweth, K, M., Langston, G. I., Yun, M. S., Lockman, F. J., Rubin, K. H. R., Scoles, S. A., 2008, AJ, (in press).

Thilker et al. 2004, ApJL, 601, L39

Wakker & van Woerden 1997, ARAA, 35, 217

Yun 1999, in Galaxy Interactions at Low and High Redshift, vol 186 of IAU Symposium, 81

Yun, M. S., Ho, P. T. P., Lo, K., Y. 1994, Nature, 372, 530

Atacama Large Millimeter Array

ALMA Project Progress

The fifth anniversary of the February 23, 2003 signing of the Agreement concerning the Joint Construction and Operation of the Atacama Large Millimeter Array (ALMA) saw the project entering the last year before commissioning observations will commence. In December, the U. S. Congress enacted the FY2008 budget, which provided funding for the seventh year of ALMA construction at the level requested by the National Science Foundation. In early February, the President requested funding for FY2009, the eighth year of this eleven year project. In preparation for deployment of the first stations of the array next year, the infrastructure at the mid-level and high altitude sites has reached a mature state and components of the array continue to stream to the ALMA sites around the world. The Proceedings of the November 2006 ALMA Conference in Madrid, *Science with the Atacama Large Millimeter Array: A New Era for Astrophysics*, has been published by Astrophysics and Space Science as Volume 313, Numbers 1–3, dated January 2008. This volume gives a wide-ranging overview of the types of science ALMA will produce.

Figure 2. The huge ALMA antenna transporters, foreground, arrived at the Operations Support Facility, background, on February 14, 2008.

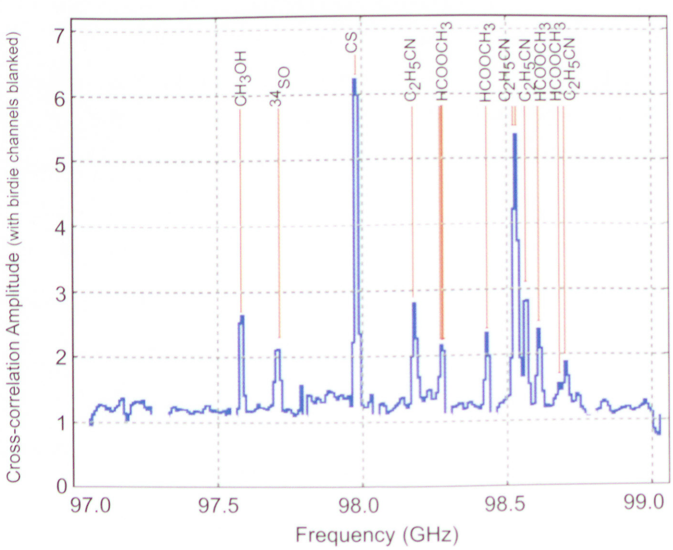


Figure 1. The first spectrum obtained with the ALMA prototype antennas at the ALMA Test Facility used the evaluation receivers and production backend equipment. Blanked channels represent missing data.

Software and hardware components of ALMA have been under test at the ALMA Test Facility (ATF) in New Mexico. As these tests reach maturity this site will close and final testing of production components will occur at the Operations Support Facility near San Pedro de Atacama in Chile. Highlights of the recent testing in New Mexico have included continued routine interferometry. A recently installed scaled down version of the main correlator was installed last year; in January this produced its first interferometric spectrum, shown in Figure 1, taken in the lowest resolution mode of the correlator. Single antenna spectra of the SiO maser line at 86 GHz were also obtained, to test spectral line pointing of individual antennas.

Production equipment continues to arrive at the ALMA sites. The correlator for the Atacama Compact Array was installed in the Array Operations Site Technical Building (AOS TB) at 5000m elevation by personnel from the National Astronomical Observatory of Japan late in 2007. Excavation for the antenna stations has begun near the AOS TB. At the 2900m altitude of the Operations Support Facility, the Technical Building (OSF TB) complex construction was completed (left of Figure 2). The third VertexRSI antenna was delivered and assembled in the Site Erection Facility (SEF, right,

Figure 3. Construction on the OSF technical facility complex has been completed. The antenna assembly building (left) and technical building (right) are shown here.

Figure 2) while acceptance testing of the first of these antennas began (this antenna is situated to the left of the SEF in Figure 2). The fourth VertexRSI antenna is en route to Chile as this is being written.

Adjacent to this facility lies the Mitsubishi antenna erection area, to which the fourth and final Mitsubishi 12m antenna was delivered at year's end. Acceptance tests of the first of these antennas are well along. At the close of 2007, seven ALMA telescopes have been delivered to Chile, about one tenth of the total. As they are accepted, antennas will be moved to the grounds of the OSF TB where they will be outfitted with produc-

Figure 4. The antenna transporters travel through the Cordillera del Sal toward San Pedro de Atacama, lying just beyond, and the ALMA operations site, to the right of this image on the flanks of the Andes. Licancabur is to the right.

Figure 5. The pedestal for Vertex Antenna No. 3 and the backup structure have now been mated. VertexRSI antenna No 2, fully assembled, is in the Site Erection Facility.

tion equipment, including the receiver packages, and tested in a continuation of the activities currently under way at the ATF. The antennas will be moved by one of the two transporters, capable of lifting antennas weighing 115 tons and placing them on foundations with a precision of millimeters. Both of these machines, weighing 130 tons each, embarked from the Scheuerle Fahrzeugfabrik GMBH factory and embarked on their journey to port at Heilbronn, Germany.

These behemoths, named Otto and Loge at a ceremony last October, travel on 28 tires and extend 30 feet in width and 60 feet long; they are 18 feet high. They were transferred to a barge to continue the journey down the Neckar River past Heidelberg to the Rhine, then down the Rhine to Antwerp, Belgium. By December 11, they had arrived in Antwerp, where they were transferred to an ocean vessel that arrived in port at Mejillones, Chile on February 7. On February 14, 2008 they completed their journey to the ALMA operations base camp at 9600 ft elevation, where they were within sight of their intended cargo, the seven antennas now at the OSF, for the first time. After a few months of testing, they will move the first antenna accepted to an antenna foundation at the just-finished OSF TB for early antenna testing. Eventually these two well-traveled giants will move the antennas to the 16400 foot level at which ALMA observes, each powered by two 500 kW diesel engines.

"When completed in 2012, ALMA will be the largest and most capable imaging array of telescopes in the world," said Massimo Tarenghi, the ALMA Director. "The ALMA antenna transporters, which are unique technological jewels, beautifully illustrate how we are actively progressing towards this goal."

Professor Thijs de Graauw (SRON and Leiden University, Netherlands) has agreed to accept the position of ALMA Interim Director, effective 1 April 2008. The search for a new Director is ongoing and vacancy notices have been posted on the websites of the ALMA Executives. In early February Dr. A. J. Beasley, ALMA Project Manager, announced his decision to resign effective in late June to attend to family responsibilities. Dr. Richard Prestage, currently Assistant Director for Green Bank Operations at NRAO, announced that in May he will join the Joint ALMA Observatory as Head of Technical Services. He will join Dr. Lars-Ake Nyman, Head of Science Operations and Russell Smeback, Head of Administration, in the Santiago offices. Also moving to Santiago will be Dr. Pere Planesas, currently at OAN, Madrid, and Dr. R. Sramek, of NRAO, who are members of the Assembly, Integration and Verification (AIV) science team.

Al Wootten

North American ALMA Science Center

Staffing remains a high priority for North American ALMA operations. We expect to fill two Commissioning and Science Verification (CSV) positions, an ALMA EPO Program Officer, and a CASA developer, in the next few months. See *http:// www.nrao.edu/ administration/personnel_office/careers.shtml.*

The international operations IPT meeting was held in Charlottesville in March, hosted by John Hibbard, where details on the implementation of the operations plan were discussed. John also visited STScI to review their HST User Support functions.

NAASC staff continue to be involved in extensive testing and training for the CASA data reduction package (*http://casa.nrao.edu*), led by Crystal Brogan. The initial deployment of the first beta CASA release to members of several ALMA science advisory committees including the ALMA North American Science Advisory Committee (ANASAC), as well as the inauguration of our CASA helpdesk system over the last few months, has been successful. The feedback we have received from this process has been very useful in refining our development plans. We expect to offer CASA tutorials at the upcoming Eleventh Synthesis Imaging Summer School and to make the package available as a beta release to the astronomical community this summer. Testing continued on the pipeline, simulator, and obstool .

Work continues on the spectral line database. Please see the accompanying *Newsletter* article on recent developments on this database.

The NAASC AD's office is preparing material on ALMA operations for the on-going AUI operations review, as well as for the up-coming Visiting and Users Committee meetings. We have also sent the revised version of the MOU with Canada on ALMA operations to James di Francesco at HIA for final comment.

NAASC staff are participating in the turno staffing at the ALMA Test Facility in New Mexico. This activity involves prototype antenna and software testing, to gain familiarity with the system, in preparation for support of Early Science at ALMA.

We are in the process of organizing the 3rd annual NAASC science workshop in collaboration with the ANASAC. This year's workshop will be on the topic of *Massive Star Formation Within and Beyond the Galaxy* and it will be held in Charlottesville

September 25-27, 2008. Please see the accompanying *Newsletter* article for more details. The ANASAC is also considering scientific input into the ALMA development plan.

Operations staff in Chile are under going extensive training as part of AIV/CSV activities. In the coming year, ALMA Chilean operations will be hiring a significant number of operations staff, including astronomers. See: *http://www.alma.cl/jobops/*

NAASC staff have visited a number of institutions and presented summaries of ALMA science and status. If your institution is interested in having an NRAO staff member visit and discuss ALMA, please contact me at *ccarilli@nrao.edu.*

Chris Carilli

The ALMA Spectral Line Catalog

The "beta" release of the Database for Astronomical Spectroscopy: *Splatalogue* occurred on February 1 and is available at *http://www.splatalogue.net*. The release was made available to the entire astronomical community but with an emphasis on those researchers familiar with the public catalogs available for molecular spectroscopy including the Cologne and JPL Databases, and the Lovas list of detected astronomical transitions. The main purposes of the release were to:

1) illustrate the power of the search capabilities of the database over all available line catalogs;
2) introduce a new catalog to the community, the Spectral Line Atlas of Interstellar Molecules (SLAIM) which will only be available through Splatalogue;
3) provide the community with a complete list of frequencies of H, He and C recombination lines;
4) add newly detected transitions to the Lovas list of detected astronomical transitions and
5) provide a limited sample of species (~200 out of 650) where the quantum numbers between all 4 catalogs were resolved, provide the line strength and energy levels in all useful astronomical units, and provide the community with an NRAO recommended rest frequency for a molecular transition.

Feedback on these goals have been sent to the ALMA Working Group on Spectral Line Frequencies and updates and corrections are ongoing. Splatalogue was also presented at the 211th AAS meeting in Austin, TX.

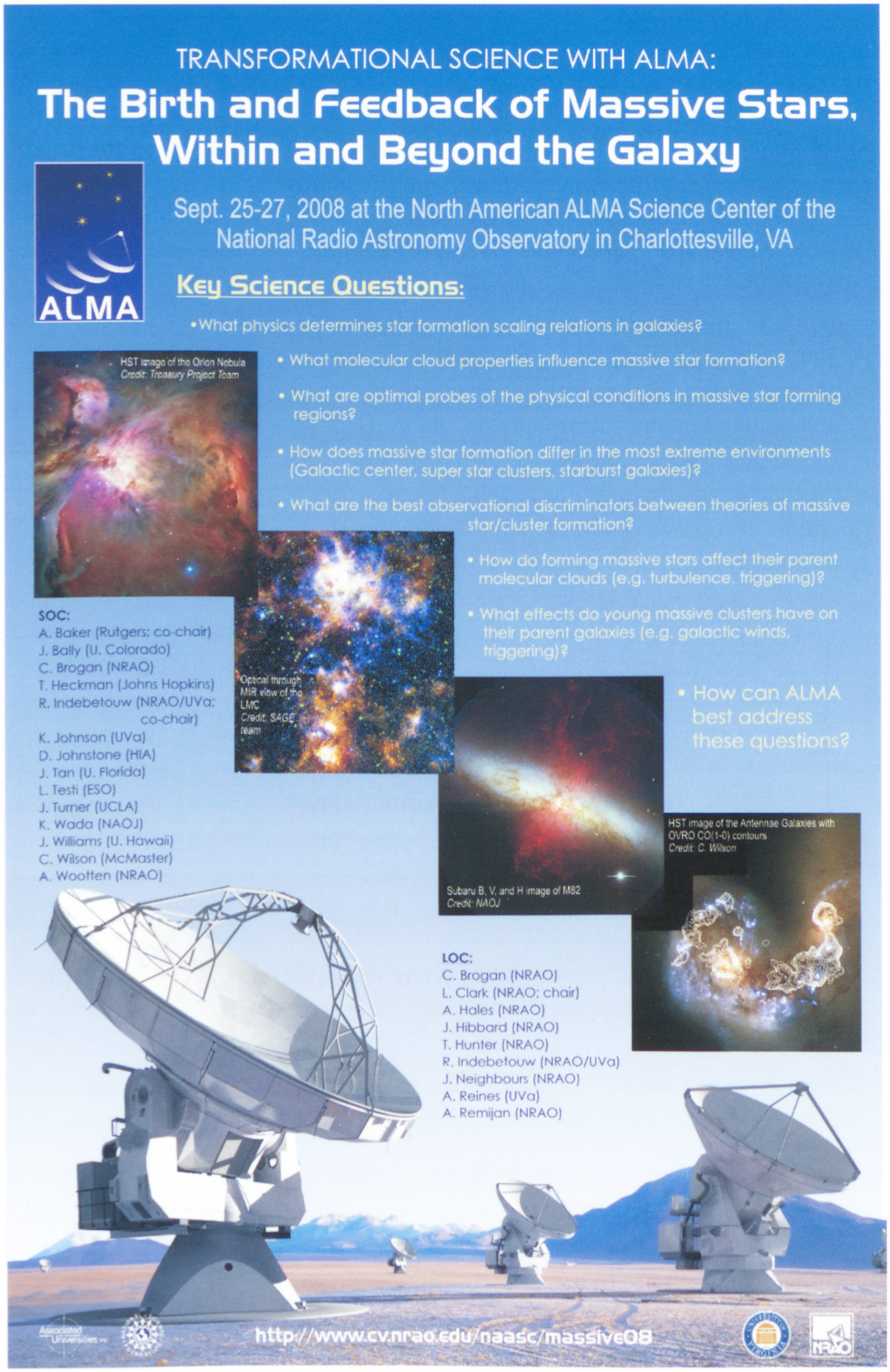
We anticipate a "Beta 2" release in June 2008 which will continue the work already started on the resolution and reconciliation of quantum numbers and species between all four catalogs. In the "Beta 2" release, all species will have consistent quantum numbers and the line strengths and energy levels will be available in all useful astronomical units for each transition. In addition, the default search criteria for Splatalogue will be only on NRAO recommended rest frequencies. There will also be additional search criteria and filters available, flexibility in exporting the data from a selected search, template spectra of selected astronomical environments including hot molecular cores and protoplanetary nebulae from cm to mm wavelengths, and a limited functionality to generate synthetic spectra based on the physical conditions of the astronomical environment and the type of telescope used to make the observation, including but not limited to ALMA and the EVLA. Future plans include presenting *Splatalogue* at the 63rd OSU meeting on Molecular Spectroscopy in June 2008 and the creation of *my.splatalogue.net* where researchers can save and recall their most used and searched on criteria. Any questions on the form, functionality and use of *Splatalogue*, please contact Anthony Remijan at *aremijan@nrao.edu* or Andrew Markwick-Kemper at *andrewjmk@gmail.com*.

Anthony Remijan

The Birth and Feedback of Massive Stars, Within and Beyond the Galaxy: The NAASC Science Workshop for 2008

The North American ALMA Science Center will host its third annual science workshop in Charlottesville from September 25–27, 2008. The subject of this year's workshop is *The Birth and Feedback of Massive Stars, Within and Beyond the Galaxy*—a timely theme, given the ability of ALMA's frequency coverage, sensitivity, and resolution to bridge the gap between Galactic and low-redshift extragalactic studies of star formation and feedback. Key science questions for the workshop include:

- What molecular cloud properties influence massive star formation?
- What are the best observational discriminators between theories of massive star/cluster formation?
- How do forming massive stars affect their parent molecular clouds (e.g., turbulence, triggering)?
- How does massive star formation differ in the most extreme environments (e.g., Galactic center, super star clusters, starburst galaxies)?
- What physics determines star formation scaling relations in galaxies?



More details about the program and logistics can be found at the workshop website: *http://www.cv.nrao.edu/php/meetings/massive08/*. The organizers encourage students, postdocs, and senior scientists working on relevant theoretical and (at all wavelengths) observational projects to preregister and submit abstracts before the deadline of May 1. A majority of the program will be selected from contributed abstracts, with a particular focus on the "wish list" of topics that have been prioritized by the organizers and listed on the website under "meeting philosophy". We look forward to seeing you in Charlottesville this fall!

A. Baker and R. Indebetouw

Expanded Very Large Array

Current Status

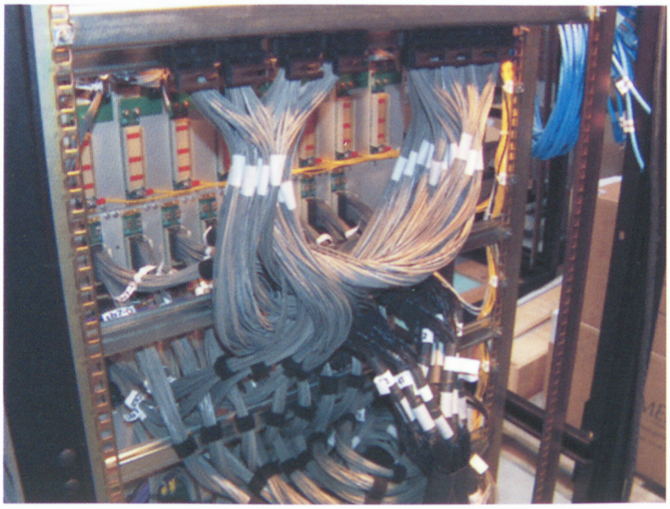


Figure 1. High speed data cables installed in a WIDAR station rack.

The rate of antenna retrofits to the EVLA design is proceeding at the desired rate of about six antennas per year. A total of 14 EVLA antennas are now used in scientific observations and account for over 48 percent of all antenna hours used in observations. The retrofitting of the 15th EVLA antenna is underway.

Preparations are underway for the delivery of the prototype WIDAR correlator to the VLA site in mid-2008. Most components for correlator rack assembly are in place. The racks will be delivered to the VLA site in two shipments of eight racks each in the late spring and early summer of 2008. The assembly, labeling, and testing of the high-speed Meritec cables, which are used for interconnecting the correlator racks (Figure 1) were completed in Penticton, British Columbia. The 128 rack-to-rack cable bundles were delivered to the VLA site in March 2008.

The beta prototypes of the correlator baseline board and station board were fabricated and delivered to Penticton in January 2008. Some problems were encountered with the fabrication of the baseline board, but no problems were found with station board fabrication. To reduce risk in the fabrication of baseline boards for the prototype correlator, quotations have been requested from two other suppliers, and more than one printed circuit board fabricator will build the boards. Board fabrication is on track for the delivery of the prototype correlator in mid-2008.

Correlator chips are being produced by the chip manufacturer, iSine. The first set of 1,200 chips will be used for qualification testing and for the prototype correlator boards. The remaining 11,000 chips should be available in the summer, well in advance of final board production. A company that specializes in industry-standard integrated circuit qualification, failure analysis, and screen testing was selected to test the chips and evaluate production reliability.

The two prototype quad-ridge sections of the S-Band (2–4 GHz) orthomode transducer (OMT) were delivered to Socorro. Laboratory tests of the OMT conducted in January 2008 show that the unit meets specification. The old VLA L-Band (1–2 GHz) dewar will be reused for the new S-Band receiver, and drawings are being made to document the required dewar modifications.

The quad-ridge sections of the prototype C-Band (4–8 GHz) OMT are meeting specifications. Two issues remain to be resolved before the OMT can be placed in full production:

(1) the selection of an OMT hybrid that functions reliably at cryogenic temperatures; and

(2) the phase matching of the OMT's two polarizations.

The prototype Ka-Band (26–40 GHz) receiver generally meets specifications and is currently undergoing tests of its local oscillator drive level. Preparations are being made for the mass production of the Ka-Band receivers this year.

Good progress continues on the production of feed horns for the EVLA receivers. The fiberglass lamination of 26 L-Band feed horns has been completed. All of the aluminum rings for the L-Band horns have been fabricated, and the fabrication of the rings for the S-Band horns continues. The purchase order for the centrifugal castings of components needed for the S-Band horn was placed, and the contract for the production lamination of the horn was issued in March 2008. The prototype S-Band horn was installed in an EVLA antenna (Figure 2). The machine shop in Green Bank built two prototypes of the Ku-Band (12–18 GHz) horn. Ten mounting towers for the Ku-Band feed horns have been completed.

The redesigned L352 round trip phase module has been assembled and tested. The module now meets or exceeds all performance specifications. The project quantity of these modules will go into production after some minor modifications to the L352 printed circuit board and a final test in the array.

A production order for the gain slope equalizers was placed, and partial deliveries of the equalizers have been received. The equalizers flatten the EVLA's wide (2 GHz) bandpass prior to digitization and are located in the T304 downconverter module.

The final versions of the P301/302 power supplies are now being refit into the antennas. They include full monitor, control, and safety features, as well as additional temperature sensors for the electronics racks and vertex room. These sensors have already enabled us to identify stability issues in the HVAC system and to correlate local oscillator stability issues with temperature changes. The remainder of these modules should be upgraded by mid-2008.

The production of the M302 and M303 utility modules was started in December 2007. The modules provide a number of functions, including temperature sensors and emergency shutdown capabilities, to the vertex and pedestals rooms of the antennas.

Considerable work has been devoted to the monitor and control (M&C) system for the WIDAR correlator. Delay and phase models for the station boards have now been implemented and tested. Support for the correlator module interface board has been added for the

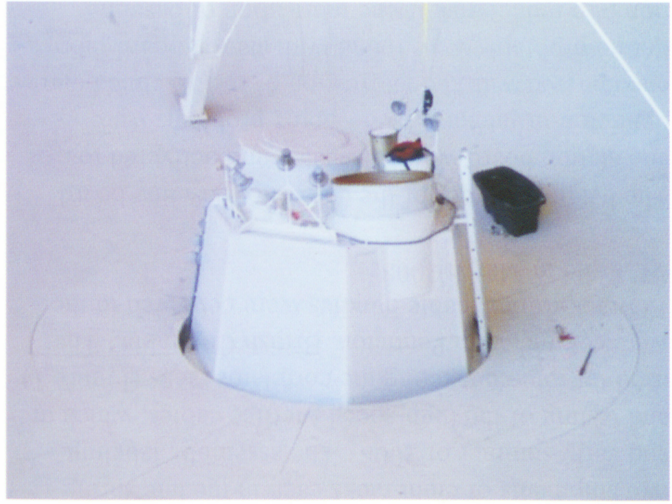


Figure 2. First S-Band feed horn installed in an EVLA antenna.

new baseline board phased array design. The graphical user interface for the correlator's retiming, crossbar, and phasing boards was completed. A draft of a joint ALMA/EVLA correlator output Binary Data Format (BDF) specification document was completed. The BDF will allow the two interferometers to have a common data format, saving much effort on archive writing and reading software. A preliminary design has been made for the Meta-data Capture and Format (MCAF) subsystem. MCAF has been prototyped with focus on data collection, Science Data Model (SDM) handling, and communications.

Transition observing continues to operate relatively smoothly under the EVLA M&C system. For example, the control and monitor processor has now run for well over 100 days without a crash, a significant improvement over the previous state. Recent significant improvements to the M&C system include the support of VLBA/VLBI observing, solutions of cross-hand delays, cleaning up of many timing and data labeling issues, and an improved document tracking system for documents sent between the Executor and Interim Data Capture and Format. In addition, two new versions of the EVLA Operators Software were released, with improvements to the fringe and alert screens and a new screen for feed heater status.

Instrument configuration capabilities were added to the Observation Preparation Tool (OPT). The OPT now has a model of the EVLA antenna electronics that can be used for baseband tuning. New ideas were developed for how the configuration of the WIDAR correlator will be presented to users of the OPT. The look and feel of the OPT was changed to be more like that of the Proposal Submission Tool.

An initial design for archiving the visibility data from WIDAR, using a BDF and SDM that are consistent with that for ALMA, has been developed. The design will easily support the data rates from the prototype correlator.

Work is being completed on the parminator, a web-based replacement for parmstool, which is an interface that operators will use to maintain many of the parameters essential to the operation of the EVLA. A document that gives a detailed description of the values in this database was written. The document was used to implement a system for rigorous error checking.

M. M. McKinnon and the EVLA Project Team

Socorro

VLA Configuration Schedule

Configuration	Starting Date	Ending Date	Proposal Deadline
C	07 Mar 2008	27 May 2008	1 Oct 2007
DnC	06 Jun 2008	23 Jun 2008	1 Feb 2008
D	27 Jun 2008	15 Sep 2008	1 Feb 2008
A	03 Oct 2008	12 Jan 2009	2 Jun 2008
BnA	23 Jan 2009	09 Feb 2009	1 Oct 2008
B	13 Feb 2009	18 May 2009	1 Oct 2008

VLA Proposals

Use of the web-based NRAO Proposal Submission Tool is required for all VLA proposal submissions; please see *http://www.vla.nrao.edu/astro/prop/vlapst/*. The maximum antenna separations for the four VLA configurations are A-36 km, B-11 km, C-3 km, and D-1 km. The BnA, CnB, and DnC configurations are the hybrid configurations with the long north arm, which produce a circular beam for sources south of about -15 degree declination and for sources north of about 80 degree declination. Some types of VLA observations are significantly more difficult in daytime than at night. These include observations at 90 cm (solar and other interference; disturbed ionosphere, especially at dawn), deep 20 cm observations (solar interference), line observations at 18 and 21 cm (solar interference), polarization measurements at L-Band (uncertainty in ionospheric rotation measure), and observations at 2 cm and shorter wavelengths (tropospheric phase variations, especially in summer). In 2008, the A configuration daytime will involve RAs between 12^h and 20^h. Proposers and observers should be mindful of the impact of EVLA construction, as described at *http://www.vla.nrao.edu/astro/guides/news/*.

VLA Scheduling

VLA scheduling takes two forms, fixed date and dynamic. Some approved proposals will be scheduled on fixed dates. Other approved proposals will be accepted for insertion into the VLA dynamic scheduling queue; a guide to VLA dynamic scheduling is available at *http://www.vla.nrao.edu/astro/guides/dynamic/*. Current and past VLA schedules may be found at *http://www.vla.nrao.edu/cgi-bin/schedules.cgi*. Observers should consult the "EVLA returns" page at *http://www.vla.nrao.edu/astro/guides/evlareturn/* for instructions on how to include EVLA antennas successfully.

VLBA and HSA Proposals

Time will be allocated for the VLBA on intervals approximately corresponding to the VLA configurations (see previous article), from those proposals in hand at the corresponding VLA proposal deadline. VLBA proposals requesting antennas beyond the ten element VLBA must justify, quantitatively, the benefits of the additional antennas.

For the June 2, 2008 deadline, it is possible that proposals requesting the VLBA or the High Sensitivity Array (*http://www.nrao.edu/HSA/*) may be submitted using the web-based NRAO Proposal Submission Tool. At this writing, it is unclear whether this option will be available. Further information on this option will be sent to prospective proposers in the email *News for Proposers*, approximately two weeks before the proposal deadline. In any case, for the June 2 deadline, the normal option for submitting VLBA/HSA proposals—with preparation via the LaTeX template (see *http://www.nrao.edu/administration/directors_office/vlba-gvlbi.shtml*) and submission via email to *propsoc@nrao.edu*—will still be available.

Global 3mm VLBI proposals, VLBA+Effelsberg proposals, and requests for using the Bonn correlator may only be prepared via the LaTeX template and submitted via email to *propsoc@nrao.edu* and *propvlbi@mpifr-bonn.mpg.de*. Any proposal requesting NRAO antennas and antennas from two or more institutions affiliated with the European VLBI Network (EVN) is a Global cm VLBI proposal (see below).

VLBA and HSA Scheduling

VLBA scheduling takes two forms, dynamic and fixed date. Some approved proposals will be accepted for insertion into the VLBA dynamic scheduling queue; a guide to VLBA dynamic scheduling is available at *http://www.vlba.nrao.edu/astro/guides/dynamic/*. Other approved proposals will be scheduled on fixed dates. Any proposal requesting a non-VLBA antenna is ineligible for dynamic scheduling. For example, HSA scheduling occurs only on fixed dates. Current and past VLBA schedules may be found at *http://www.vlba.nrao.edu/cgi-bin/schedules.cgi*.

Global cm VLBI Proposals

Proposals for Global VLBI Network observing at centimeter wavelengths are handled by the NRAO. There are three Global sessions per year, with up to three weeks allowed per session. Plans for these sessions are posted at *http://www.obs.u-bordeaux1.fr/vlbi/EVN/call.html*. Any proposal requesting NRAO antennas and antennas from two or more institutions affiliated with the EVN is a Global cm proposal. For all classes of proposals involving the EVN, only the on-line tool NorthStar should be used to prepare and submit proposals. Access NorthStar at *http://proposal.jive.nl*. Global cm VLBI scheduling occurs only on fixed dates.

J. M. Wrobel and B. G. Clark
schedsoc@nrao.edu

VLA and EVLA Spectral Line Observations Below 1200 MHz

Test observations below 1200 MHz have recently been carried out with the EVLA to assess the feasibility of pursuing spectral-line observations for redshifted HI 21cm or other spectral-line transitions at frequencies where the VLA has severe limitations and/or simply cannot observe.

We have observed two known HI 21cm absorbers, one at z=0.2467 (~1139 MHz) and the other at z=0.3127 (~1082 MHz). Each target was observed for about 45 minutes in B configuration using bandwidths of 3.125 MHz with 127 spectral channels. Both VLA and EVLA antennas (a total of 26) were used for the source at 1139 MHz. The inclusion of the VLA antennas in these observations was possible because the frequency falls within one of the "good VLA frequency windows" (see Figure 4 in *EVLA Memo #119* for the sensitivity of the VLA between 1100 and 1225 MHz, available at *http://www.aoc.nrao.edu/evla/memolist.shtml*). The source at 1082 MHz, however, was observed using

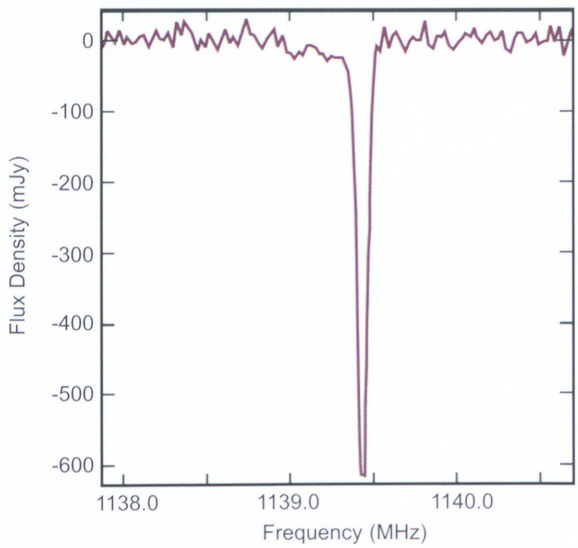


Figure 1. The HI 21 cm absorption line toward the source PKS 1413+135 at z=0.25 with the EVLA+VLA.

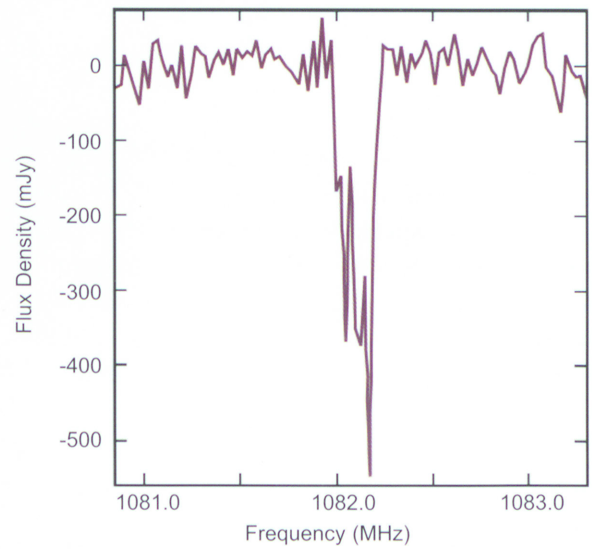


Figure 2. The HI 21 cm absorption line toward the source PKS 1127-145 at z=0.31 with the EVLA.

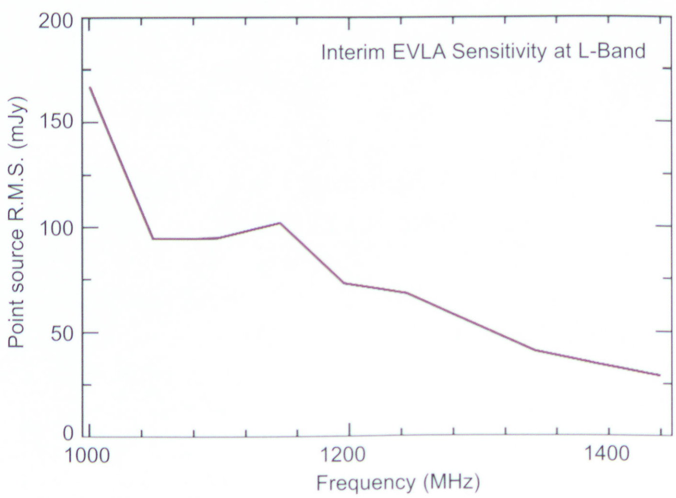


Figure 3. The point source rms values for L-Band frequencies between 1000 and 1440 MHz.

only the EVLA antennas (total of 13), because the VLA antennas cannot be tuned to frequencies below 1100 MHz.

Figures 1 and 2 show the HI absorption spectra of the sources at 1139 and 1082 MHz, with rms noise values of 4.7 and 10 mJy, respectively. We note that sensitivities below 1200 MHz will improve dramatically when the final L-Band receivers are installed through 2009.

Figure 3 shows a representation of the point source rms values obtained by observing a blank field every 5 MHz between 1000 and 1200 MHz. Values obtained at 1350 and 1440 MHz are also included for comparison purposes. The observations were carried out at night time with ten EVLA antennas in CnB configuration. The imaged bandwidth at each frequency setting is 24 kHz and the integration time is 100 sec. It should be noted that for observations below 1200 MHz, only IF pair B and D can be used at this time. Furthermore, we note that the polarization performance below 1200 MHz is severely compromised, with the polarization impurity reaching 40 percent at 1 GHz.

These test observations show that successful observations are possible with the EVLA at frequencies that are believed to be dominated by RFI due to aeronautical navigation transponders, at least in A and B configurations. As this RFI is more evident on the shorter spacings, as well as at day-time hours, more tests will be carried out at various hours of the day and in C and D configurations to fully assess the limitations on astronomical observing due to these transmissions. We expect that daytime observations at these frequencies may be much more difficult.

This new 1.0-1.2 GHz capability on the EVLA is now available for users, and NRAO will consider exploratory proposals to use it in the current configuration through the end of D configuration, September 15, 2008.

Please ensure that any proposals are labeled as *Rapid Response—Exploratory Time*. Any further information to supplement that given above will be posted at the EVLA returns web page, at *http:// www.vla.nrao.edu/ astro/guides/evlareturn/*. Potential users are advised that these are "shared risk" observations. We cannot guarantee success, especially for daytime observations that might be severely affected by RFI, but we will provide reasonable assistance. Note that proposals for A configuration should be submitted as usual at the June 2, 2008 deadline.

Technical questions about observing below 1200 MHz should be directed to E. Momjian at *emomjian@nrao.edu*. For information about the special call for exploratory proposals to use the new tuning capabilities please contact C. Chandler at *cchandle@nrao.edu*.

E. Momjian, R. Perley, C. Chandler

Status of Observing with the Transition Array

As this newsletter goes to press, there are 14 fully functioning EVLA antennas in the array, which means that for the first time retrofitted EVLA antennas outnumber the old VLA antennas.

During the last few months a number of improvements of interest to observers have taken place:

1. A series of fixes to online flagging was implemented that further reduce the presence of bad data on EVLA baselines. Although we continue to advise observers to check their data with care, we are confident that the quality of flagging of EVLA antennas is now approaching that of VLA antennas.

2. Planetary observing is now supported, although we strongly advise planetary observers to solicit local staff support well ahead of their planned observations.

3. The executor automatically turns off correlator self-test when observing at 25MHz spectral line, which has shown to eliminate the DC offset problem reported in deep observations in this observing mode.

The main problem currently still with us, affecting mainly narrow bandwidth spectral line observations, is the aliasing of emission around baseband. This affects data on EVLA—EVLA baselines in the lowest 0.7 MHz of the total bandwidth (or the highest 0.7 MHz for X- and U-Band). In some cases the line emission can be recovered by applying the AIPS task UVLSF which has been adapted especially for this purpose, but requires at least 50 percent of the spectral line channels to be line-free. The problem is even more serious when the line emission of interest continues below baseband. This means any continuum emission cannot be reliably recovered; it also compromises stitching together line data from two IF pairs partially overlapping in frequency.

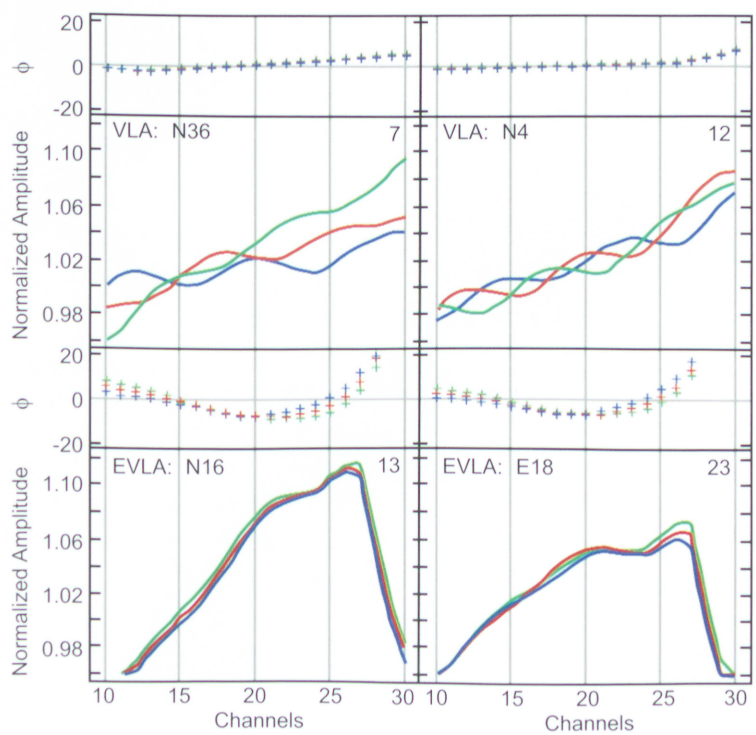


Figure 1. Normalized amplitude and phase bandpass solutions for VLA Antennas 7 and 12 (top panels) and EVLA Antennas 13 and 23 (bottom panels), for three observing frequencies: 8448 MHz (green), 8450 MHz (blue), and 8452 MHz (red). In each case the total observing bandwidth is 12.5 MHz.

In January 2008, it was discovered that small frequency differences between source and calibrator (e.g. of the kind normally introduced by Doppler tracking on both with the same velocity) causes phase changes, which make it impossible to apply calibrator solutions to the source. A fix to this problem is currently being implemented. Until this is thoroughly tested, source and phase calibrator must be observed at the same frequency, i.e., observers should not use Doppler tracking.

Bandpasses, on the other hand, are much more insensitive to frequency differences for EVLA antennas than they are for VLA antennas, as the latter are affected by standing waves in the waveguide. This is illustrated in Figure 1, which shows the normalized bandpass amplitudes and phases at X-band for two VLA antennas and two EVLA antennas over 12.5 MHz total bandwidth for observing frequencies 8448 MHz (green), 8450 MHz (blue), and 8452 MHz (red). Note the variation (the "3 MHz ripple") in VLA Antennas 7 and 12, and the much more stable behavior for EVLA Antennas 13 and 23. Our first tests indicate that EVLA bandpasses are equally stable at other bands as well.

For the latest news on these and other items, please consult our EVLA returns web page at http://www.vla.nrao.edu/astro/guides/evlareturn.

G. van Moorsel and C. Chandler

VLBA Sensitivity Upgrade Project

Substantial progress has been achieved in all three development areas of the VLBA 4 Gbps data path expansion, the major component of the VLBA Sensitivity Upgrade Project. An overview of the 4 Gbps project appeared in Issue 111 of this *Newsletter*, and detailed reports on specific sub-projects appeared in Issues 112 and 113. This article is an update on recent progress. Ongoing documentation on the entire VLBA Sensitivity Upgrade Project is available in the project memo series, which can be accessed on the NRAO website at *http://www.vlba.nrao.edu/memos/sensi/*.

Work on the Digital Backend (DBE) sub-band processor module has concentrated on final design and layout of the ROACH (Reconfigurable Open Architecture for Computing Hardware; formerly known as "iBOB-2") board that will serve as the hardware platform for the DBE. ROACH is a further development of the UC Berkeley CASPER laboratory's very successful iBOB. This device includes a new, high-capacity Xilinx Virtex-5 FPGA, a PowerPC control processor, and a variety of appropriate I/O interfaces. In particular, a 10G Ethernet output interface will support separate packet streams for individual sub-bands. Final ROACH design and layout was recently completed in a collaborative effort among NRAO, CASPER, and the South African KAT project. Prototype boards have been ordered, with deployment on the VLBA, the VLA, and GBT, anticipated by mid-2008.

Reaching this stage of platform completion allows NRAO engineers to turn to development of the FPGA code to implement DBE functionality. As described in greater detail in Issue 112, this effort is a collaboration with Haystack Observatory, in which NRAO is responsible for a Digital Downconverter FPGA personality that will find its principal application in narrowband spectroscopy, while Haystack will transfer the Polyphase Filterbank personality from their existing DBE-1 device to the new ROACH platform, to support primarily wideband continuum observations.

The Mark 5C wideband recording system is optimized to accept input from the DBE via an industry-standard 10G Ethernet interface, to record the packet payloads at a 4 Gbps data rate, and to deliver output to a software correlator directly over the Mark 5C unit's bus. NRAO has joined with Haystack Observatory and Conduant Corporation, which together originated the Mark 5 recorder line, in a joint development of Mark 5C.

Final specifications for Mark 5C were adopted recently by all parties, after a preliminary review by international VLBI recording experts. These documents are available in Memos #12, #13, and #18. Mark 5C will maintain compatibility with existing Mark 5 disk modules, to preserve the investment in recording media by NRAO and other observatories.

Conduant already has in production an "Amazon" streaming interface to the disk array, which is capable of the 4 Gbps transfer rate. The only new development required for Mark 5C is a new daughter board to receive the DBE's 10G Ethernet output; design of this board is nearing completion and was confirmed in a recent review. Prototype units have been ordered from Conduant, with delivery expected by mid-2008, and a contract is in place with Haystack for assistance in the final design, development of the control software, and testing of the initial units.

The DiFX software correlator system, and NRAO's implementation thereof, was the subject of our latest VLBA Sensitivity Upgrade Project article, in Issue 113 of this *Newsletter*. Several more recent developments are particularly noteworthy.

All peripheral software required to interface DiFX to the VLBA's end-to-end data flow is now complete. Initially, DiFX derives its control information from the same correlator job scripts used by the existing hardware system. In addition to minimizing current development effort, this approach guarantees accountable parallelism for comparison tests between the old and new systems. Eventually, however, we expect to adopt the VEX observation-description standard for this purpose. A standard FITS-IDI writer has been completed at the output from DiFX. These measures suffice for the tests that have already begun. The only remaining software required for routine use of DiFX are some operator-support interfaces.

An intermediate-scale computing cluster, consisting of twenty Intel Xeon quad-core processors, was recently purchased and installed to support the first large-scale use of DiFX. On the basis of benchmarks obtained with a more rudimentary system, described in Memo #17, NRAO estimates that the intermediate cluster can match the existing correlator's throughput.

J. D. Romney, W. F. Brisken, S. J. Durand, G. Peck, M. D. Revnell, and R. C. Walker

Green Bank

First 3mm Science Observations with the GBT and MUSTANG Call for Proposals

The MUSTANG bolometer camera was installed on the GBT in early December 2007 for a second commissioning run, and given the success of the run, to execute the refereed early science proposal submitted by the team for trimester 08A. The performance and robustness of the instrument on the telescope has thus far been outstanding. Substantial progress has also been made in the data analysis algorithms (principally in the OBIT package). As an illustration, the accompanying Figure 1 shows a 90 GHz map of the Crab supernova remnant. Figure 2 shows a map of the Orion A region. So far just over 50 square arcminutes of Orion have been imaged to a noise level of about 2 mJy RMS. MUSTANG detects both free-free emission from the nebular gas ionized by the O stars in the Trapezium and thermal dust emission from the dense molecular cloud OMC 1 in the background. Combined with other data sets of about the same spatial resolution (e.g. VLA and/or GBT continuum for the free-free and

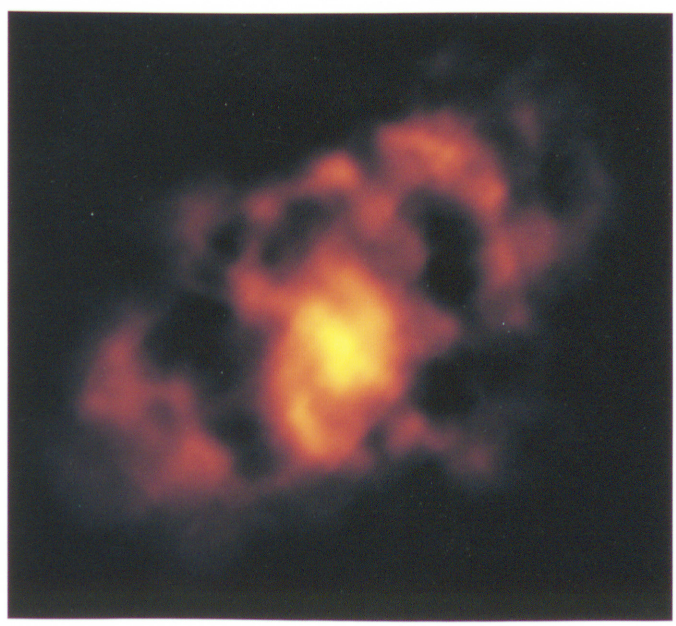


Figure 1. 90 GHz image of the Crab SNR made with MUSTANG on the GBT. The size of the image is approximately 8′×8′; MUSTANG's instantaneous field of view is 32″×32″.

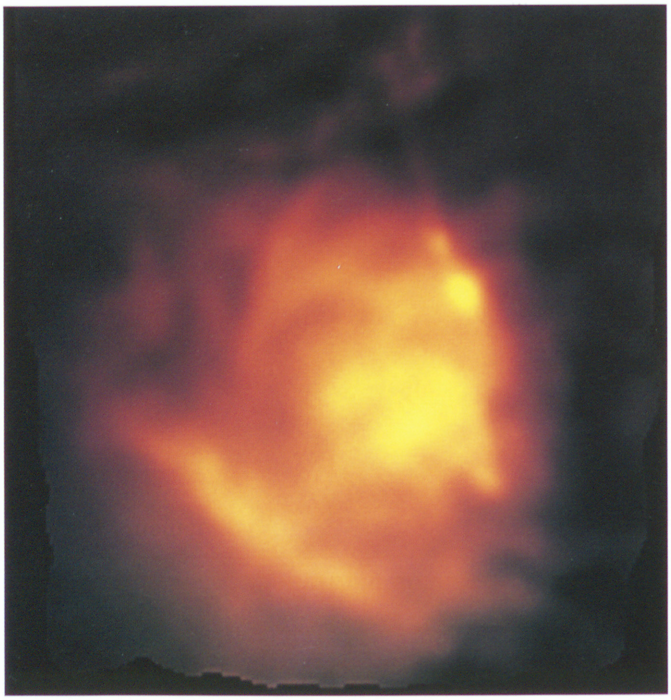


Figure 2. Map of the Orion A region made with MUSTANG, the GBT's 90 GHz bolometer array.

SCUBA 450 and 850 microns for the thermal dust emission), spectral decomposition of the MUSTANG maps will be used to study the dust emissivity as a function of the wavelength and its possible variation through this region.

As reported previously, MUSTANG (the Multiplexed SQUID TES Array at Ninety Gigahertz) achieved first light in engineering observations on the GBT in September 2006. The MUSTANG receiver was built by a collaboration that included the University of Pennsylvania, NRAO, GSFC, NIST, and Cardiff University. The basic functionality of all aspects of the system and interfaces (optics, cryogenics, detectors, SQUID multiplexers, data acquisition and control software, etc.) was demonstrated in situ. In the process the observation and data analysis procedures were improved considerably. The team confronted a number of challenges during the run, chief amongst them a previously known source of significant 1/f noise in the receiver. In spring 2007 this noise was determined to be caused by low-level vibrations in the pulse tube cooler—which provides the first two stages of cryogenic cooling—and successfully mitigated by redesigning the cold heat straps and soft-mounting the pulse tube at 300 K. As a result of this work the sensitivity of the instrument is now approximately five times what it was in fall 2006. Other work over the course of the spring and summer included: procurement and installation of a 20 GHz bandpass filter, replacing the 8 GHz filter used in initial observations and yielding a further factor of 2.5 in sensitivity (since the instrument is receiver noise limited); cleaning and rebuilding the pulse tube cooler and procuring a spare; and installing faster heat switches and more powerful heaters to reduce cycle times. Modifications were also made in the interface of the instrument to the GBT's 1000 foot-long helium supply lines and in helium-fill procedures.

In the fall, work commenced in Green Bank on the task of migrating the Java software used for early data acquisition and control over to GB's Monitor and Control framework, YGOR. In February 2008 tests the YGOR manager was successfully used to fully configure MUSTANG and to acquire and record the data to a FITS file. Further work on users interfaces, tuning algorithms, and observing and data analysis software will take place over the summer, leading to a final systems-commissioning run in the upcoming winter. This work, along with ongoing efforts by the PTCS team to improve and characterize the antenna, are aimed at moving GBT 3mm observations from the shared-risk category into a general user mode.

Based on these promising first results from the receiver, proposals for shared-risk science observations will be accepted in the June 1 call (see the article later in this *Newsletter* for more details). Information on the expected performance of the instrument can be found at: *http://www.gb.nrao.edu/mustang/*.

Accepted proposals should be carried out in collaboration with the instrument team, and proposers are encouraged to consult the instrument team concerning questions of technical feasibility prior to submission of proposals. Contact Brian Mason (*bmason@nrao.edu*) with further inquiries.

B. S. Mason (NRAO), S. Dicker (UPenn) and MUSTANG collaboration (UPenn, NRAO, NASA-GSFC, NIST, Cardiff University)

GBT Dynamic Scheduling System Update

The new GBT Dynamic Scheduling System (DSS) project has made significant progress on the software needed for the upcoming DSS tests which are to be run during the summer trimester (June–September 2008). The quarter has seen the development of calendars to show upcoming projects and sessions, and a web-based interface in which investigators can update their project and session information, investigate the probability of their project being scheduled, etc. We have also implemented RSS technology which will allow investigators to be notified when any significant event occurs with their project(s) (e.g. the project is scheduled or information on a given project session is needed). Additionally, the software is now fully implemented to allow for complete testing of the DSS system over a given trimester or year (using historical weather data). Importing of data from the NRAO Proposal Submission Tool (PST) has also been implemented, minimizing the effort needed by observers to update their project information.

Up-to-date information on the DSS and the tests to be run during the 08B trimester can be found at *http://www.gb.nrao.edu/DSS*.

Karen O'Neil

Progress on the GBT K-Band Focal Plane Array

In February, the GBT K-Band focal plane array (KFPA) program successfully completed its conceptual design review, which addressed system specifications and component design details, with an emphasis on obtaining specific scientific goals. Mapping nearby star-forming regions to study the density and temperature in star-forming cores, as well as the role of turbulence and inflows and outflows, are prime examples. The committee also reviewed the expandability of the design from seven to approximately 61 pixels, and the approach to data analysis and M&C software plans. They recommended proceeding with the system specifications given in Table 1. They endorsed the approach of designing an expandable array without sacrificing the seven pixel array schedule. Appreciating the complexity of the mechanical design for a larger array, many helpful comments were forthcoming.

We have in place a letter of intent (LoI) with the University of Calgary. This collaboration has provided a framework for developing a data analysis pipeline. The LoI proposes 0.3 to 0.5 FTE support for component development. Their experience with the Arecibo\GALFACTS data pipeline will expedite the development for commissioning and prototype tools that support an expanded array. Equally important, but with more technical details to be addressed, is the LoI for a collaboration with a Canadian group that will deliver a correlator capable of processing the entire 1.8 GHz bandwidth.

Results comparing the theoretical and measured feed performance with the associated GBT aperture efficiencies were presented during the review. An analysis of mapping strategies of ammonia in star-forming cores, with sizes comparable to the GBT beam (about 30 arcseconds) at the frequency of ammonia (24 GHz) and distributed on scales of a few arcminutes, determined a close-packed hexagonal feed layout as optimum. The KFPA will also be a powerful tool for interstellar chemistry searches for new complex molecules that tend to be diffusely distributed on scales of a few arcminutes.

Table 1. Baseline Instrument Specifications

Specification	Requirement
Frequency Band	18-26.5 GHz (complete K-Band coverage)
Instantaneous Bandwidth (each beam, not including sky)	1.8 GHz
T (receiver)	<25K (75% of band) <36K (entire band)
Aperture Efficiency	> 55%, any pixel
Polarization	dual, circular (axial ratio ≤ 1dB)
Polarization Isolation	>25 dB
Pixel-to-Pixel Isolation	> 30 dB
Headroom	>30 dB (to 1 dB compression point)

Simulated mapping areas ranging from 9 to 144 square arcminutes have shown that a simple raster map in any celestial coordinate system, with a Nyquist sampling perpendicular to the scan direction, provides relatively uniform coverage while spending less than 30 percent of the observing time outside of the area of interest. This is true for a range of source hour angles and declinations. For chemistry experiments, the feed pattern will rotate on the sky, but the observations will still provide for deep integrations with some information on the radial distribution of the molecules being studied.

Further information about the array is on the project wiki page at: *https://wikio.nrao.edu/bin/view/Kbandfpa.*

S. D. White and D. J. Pisano

Opportunities for University-Led Technical Development Projects in Green Bank

In addition to supporting scientific operation of the flagship 100m Robert C. Byrd Green Bank Telescope, the Green Bank site provides other resources which we make available to the scientific community, including access to the National Radio Quiet Zone, antenna test ranges and similar facilities, and the scientific and engineering expertise of our staff.

As well as scientific proposals submitted through the usual route, we welcome proposals for development to enhance the GBT's capabilities. In addition, the NRAO has preserved older telescopes for potential future use. We encourage the use of these telescopes for scientific or technical research, provided the prospective users obtain full external funding for the staff and materials costs of operation. For example, in 2003 Tim Bastian (NRAO) and collaborators received a three year Major Research Initiative (MRI) grant from the NSF Atmospheric Sciences Division to develop the Green Bank Solar Radio Burst Spectrometer (GB/SRBS; *http://gbsrbs.nrao.edu/*), an instrument to receive solar radio emissions to probe a wide variety of active solar phenomena. The SRBS uses the Green Bank 45 Foot telescope to observe the Sun on a daily basis. As another example, MIT/Lincoln Laboratories have provided funding for technology development and operations of the Green Bank 140 Foot (43m) telescope to measure the dynamic properties of the Earth's ionosphere. For this project the 43m control system was completely automated to reduce the operations costs. This project is expected to continue for the next few years (see *http://www.gb.nrao.edu/43m/*).

Other telescopes on site include three 26m antennas from the Green Bank Interferometer project, and the 20 meter telescope. The latter was mothballed in 2000 following the end of USNO Geodetic VLBI operations at Green Bank, but reactivated in 2007 as part of our collaboration with Brigham Young University on phased array feed development.

Prospective users of these telescopes must secure outside funding independent of NRAO Operations funds, which are intended primarily for operation of the GBT and associated activities. Some limited assistance from NRAO may be available for projects which directly support NRAO's primary mission (for example, training young scientists and engineers). For telescopes

A panoramic view of the Green Bank site showing a number of the telescopes.

already in use, future projects would obviously have to be consistent with current agreements. However, there is still the potential for collaborative operation of these, provided suitable accommodations can be made.

If anyone is interested in pursuing the use of any of these telescopes, we encourage them to contact Karen O'Neil (koneil@nrao.edu) for further discussions.

R. M. Prestage and K. L. O'Neil

Education and Public Outreach

New NRAO Website Debuts

The new NRAO web site is divided into three areas that serve different target audiences: (a) scientists, (b) the public, and (c) NRAO staff.

Since the largest fraction of our web site visitors are non-scientists, our new home page (left image) targets primarily the public. From this page, visitors can access content designed to address the public's fundamental questions about the Universe and the NRAO.

From the home page, scientists can access web pages that describe how the NRAO addresses their research interests and needs by two methods: clicking on the "Astronomers" hot button and via the "For Astronomers" link under "Find Resources" (right image).

As many of our readers have likely seen, a redesigned NRAO web site debuted Monday, February 25, at noon Eastern Time. This new site incorporates a simpler structure, a more compelling visual style, improved tools for content management, and presentation of the NRAO as "One Observatory".

This renovation has been a collaboration across the NRAO, including Education and Public Outreach, End-to-End Operations, scientific staff, Computing & Information Systems, and others. Our web site's high-level content has been reorganized, but existing content has not been deleted. The only page that has been completely replaced is the home page at *http://www.nrao.edu/*.

The web development team invites your feedback. Please email *webtalk@nrao.edu* to let us know of any problems you encounter or improvement ideas you have. And thank you in advance for your assistance!

M. T. Adams, D. M. Halstead, T. Johnson, P. P. Murphy, N. M. Radziwill, and S. W. Witz

The NRAO at the American Astronomical Society and American Association for the Advancement of Science Meetings

The city of Austin, Texas hosted the 211th meeting of the American Astronomical Society (AAS) from Monday, January 7 through Friday, January 11, 2008, and more than 2,500 persons attended.

Six NRAO press releases describing diverse research results from the GBT, VLA, and VLBA were distributed to the media at this AAS meeting. The release describing research conducted at the GBT by Jay Lockman (NRAO) and his colleagues—R. A. Benjamin and A. J. Heroux (both University of Wisconsin-Whitewater), and G. Langston (NRAO)—proved the most popular. Lockman et al. conducted a detailed study of a massive cloud known as "Smith's Cloud". Their neutral hydrogen observations revealed that Smith's Cloud is expected to collide with the Milky Way in 20–40 million years producing a burst of star formation. Smith's Cloud is named after its discoverer, Gail Bieger, née Smith, who was an astronomy student at Leiden University in the Netherlands. In addition to extensive print and Internet news coverage, several broadcast media outlets interviewed Lockman, including National Public Radio (NPR), the British Broadcasting Corporation (BBC), and the Canadian Broadcasting Corporation (CBC).

Our new radio program, *Cosmic Radio*, also debuted at the Austin AAS meeting. *Cosmic Radio* includes 26 programs, each ~2.5 minutes in length, and is a collaboration between NRAO and Allegheny Mountain Radio in West Virginia. Program topics range from recent scientific discoveries, to how radio telescopes explore the Universe, to the history of radio astronomy. Produced with funding from the Corporation for Public Broadcasting, the programs are free to all radio stations. *Cosmic Radio* has already been provided on CD to more than 500 NPR-affiliated stations, and the entire program set is available on-line at *http://www.nrao.edu/cosmicradio*.

A well-attended AUI/NRAO reception was held Tuesday evening during the AAS meeting. A new 4.5 minute ALMA high-definition video trailer debuted at this reception. Director Fred K. Y. Lo and AUI

NRAO Director Fred K. Y. Lo presents an award to Amy Reines (University of Virginia) for her prize winning image in the 2007 NRAO/AUI image contest (cover image).

President Ethan Schreier hosted a ceremony to present awards to the First, Second, and Third Prize winners from the recently concluded 3rd annual AUI/NRAO Image Contest.

The 2008 NRAO Calendar features these prize-winning images and was very popular with meeting attendees. The 2008 NRAO Calendar also showcases outstanding astronomical visualizations created by Travis Rector (U. Alaska), Aeree Chung (NRAO), C. Rodriguez and Greg Taylor (UNM), Juan Uson (NRAO), John Hibbard (NRAO), and last year's First Prize image by Jayanne English (U. Manitoba). All of the calendar images are available in the on-line NRAO Image Gallery at *http://www.nrao.edu/imagegallery/php/level1.php*.

A well-attended, hour-long NRAO Town Hall meeting was held for the astronomical community on Thursday afternoon, January 10. Director Fred K.Y. Lo provided an overview of the outstanding science being enabled at the NRAO and briefed the attendees on the status of ALMA and EVLA. North American ALMA Science

NRAO Education Officer Sue Ann Heatherly at the four-hour open house for families in Austin, AstroZone. Photo by Dave Finley.

EPO Assistant Director Mark Adams at the AAAS Meeting in Boston. More than 5,000 scientists and 1,000 journalists from around the world attended the event. Photo by Judy Stanley.

Center Director Chris Carilli highlighted current and future science synergies with NRAO telescopes. Jim Ulvestad updated the community on VLBA science and developments, including on-going Large Proposals; and Jay Lockman spoke about recent GBT research and instrument status. A question and answer session followed.

NRAO Education Officer Sue Ann Heatherly and Public Information Officer Dave Finley joined the AAS, the Association for Astronomy Education, and several other observatories to host and provide hands-on activities for a fun four-hour open house called *AstroZone* on Sunday afternoon that was attended by more than 400 Austin area families, teachers and young people.

The NRAO exhibited at the American Association for the Advancement of Science (AAAS) annual meeting for the first time in 2008. Held in downtown Boston from Thursday, February 14 through Monday, February 18, this year's AAAS meeting was attended by more than 5,000 scientists from around the world. The meeting attendance also included more than 1,000 journalists. The annual AAAS meeting is an excellent opportunity to communicate the NRAO mission, science, and technology to the broad science community, and the AAAS media attendance is always much larger than at a AAS meeting.

We debuted a new 15-minute ALMA high-definition video feature at the AAAS meeting. This narrated feature tells the story of ALMA science and technology and millimeter astronomy, including compelling animations, and sound bites provided by key ALMA personnel. Copies of the video were distributed to the large media contingent attending the meeting, and to persons visiting the NRAO exhibit. All NRAO videos, including this feature, can be downloaded from our web site in low, medium, and high-resolution formats.

NRAO Education Officer Judy Stanley hosted and led hands-on astronomy activities throughout the free Saturday and Sunday (10 a.m. – 5 p.m.) *Family Science Days* that were an integral part of the AAAS meeting. More than 1,500 Boston area adults, teachers, and young people participated.

Mark Adams

In General

Call for GBT Shared-Risk MUSTANG Proposals

At the June 1st 2008 deadline, proposals for shared-risk observations with the GBT's 90 GHz Bolometer Camera (MUSTANG) will be accepted (see the earlier article in this Newsletter for more details on the instrument). Since neither MUSTANG nor the GBT's 90 GHz capability are yet streamlined "production" capabilities, accepted proposals should be carried out in collaboration with the instrument team, and carry a measure of uncertainty. MUSTANG has a demonstrated sensitivity sufficient to map a 3' × 3' region to an RMS of 2.5 mJy in an hour. More detailed and up-to-date information on the expected performance of the instrument will be available at: *http://www.gb.nrao.edu/mustang/*.

Proposers are encouraged to consult the instrument team concerning questions of technical feasibility prior to submission of proposals. Contact Brian Mason (*bmason@nrao.edu*) with further inquiries.

Brian Mason

Large Proposals to Use NRAO Telescopes

NRAO encourages the submission of proposals which require significant amounts of telescope time when justified by the potential scientific payoff. We define a Large Proposal as one which requires at least 200 hours of observing time on one or more of the NRAO telescopes. We expect to allocate as much as 25 to 50 percent of available observing time on NRAO instruments to Large Proposals. The final fraction will depend on proposal pressure and scientific merit, as determined by peer review. Large Proposals will be further constrained to a maximum of 50 percent of the available observing time in any LST range during any trimester (configuration for the VLA).

The next Large Proposal deadline is June 2, 2008. This will include all NRAO telescopes (VLA, GBT and VLBA). Beginning June 2008 the Regular and Large proposal calls will be merged to the same trimester (Feb, Jun and Oct). For example, both Regular and Large VLA proposals received on this deadline are primarily intended to be scheduled in the A-array for the observing period of October 2008 through to January 2009. Proposals may request telescope time spanning more than one trimester, and proposals can be submitted for any trimester (or VLA configuration) outside the current call. Due to the EVLA construction project and new instrumentation development at the GBT, the capabilities of these instruments are changing rapidly. We will post updates and restrictions in the "Call for Proposals" issued for each telescope.

Large Proposals should be submitted by the same process as normal proposals for the individual telescopes (e-mail to *propsoc@nrao.edu* for the VLBA; the on-line NRAO Proposal Tool for the GBT and VLA). Large Proposals will be allowed a maximum of ten (10) one-sided pages (U.S. letter sized) with 11 point font (minimum) to present the scientific justification and the technical feasibility of the project, including all figures, tables and references. The cover page form is not part of this ten page limit.

A data reduction and release plan is a mandatory part of the justification for any Large Proposal. The maximum proprietary period is one year, but the proposers are free to specify any shorter time interval. Reviewers will be asked to assess the likelihood that useful scientific data products will be produced and made available within a reasonable time period. A modest amount of funding may be allocated by NRAO to assist the delivery of data products to the wider community. Financial support for students is available through the NRAO Student Observing Support Program.

All Large Proposals will first be evaluated and graded as part of the normal proposal refereeing process. These graded proposals are passed to the Proposal Selection Committee (PSC), along with a technical assessment on the feasibility of the project. This panel will be responsible for selecting successful proposals and for making recommendations to NRAO regarding their scheduling. The results will be announced in the NRAO Newsletter and on the NRAO website.

Dale Frail

Chris Carilli Appointed Observatory Chief Scientist

Chris Carilli

We are pleased to announce that Chris Carilli has accepted a new position as Observatory Chief Scientist, with the responsibility of promoting the science impact of NRAO to the broad community, and leading the formulation of science cases that propel new instrumentation and facilities within the Observatory. The Chief Scientist also serves as Chair of the Observatory Science Council that advises the Director on science directions and policies of the Observatory.

Since May 2006, Chris has served as Assistant Director for the North American ALMA Science Center (NAASC) and guided the NAASC during its all-important formative years. Most importantly, he was responsible for the submission of the ALMA and NAASC Operations Proposal to the National Science Foundation. This proposal was successful and the NSF agreed to fund ALMA operations fully.

An open search for a new Assistant Director for the NAASC is being headed by Paul Vanden Bout.

Chris will move to his new position in the Office of Science and Academic Affairs as Deputy Assistant Director as soon as his replacement as the Assistant Director for NAASC is in place. In the near term, Chris will also work on raising the profile of the EVLA project in the scientific community.

Please join us in congratulating Chris on his important new role for helping to raise the scientific visibility and impact of the NRAO.

Fred K.Y. Lo

Eleventh Synthesis Imaging Workshop

The Eleventh Synthesis Imaging Workshop will take place from June 10 through June 17, 2008, in Socorro, NM. The school will comprise a week of lectures on aperture synthesis theory and techniques at a level appropriate for graduate students in astrophysics. Basic lectures on synthesis imaging, and advanced lectures on more specialized techniques, will be included. Practical tutorials demonstrating data collection, calibration and imaging of both VLA and VLBA data will be given.

Registration opened February 4. The workshop is limited to 150 participants and is on a first-come, first-serve basis, so register early. If you need a letter of invitation for a visa, please request one as soon as you register. The registration fee is $150; early registration ends May 15 after which the registration fee will be $170, assuming there is still space available. For information on registration, travel, transportation, accommodation and for the full second announcement see the workshop web page *http://www.aoc.nrao.edu/events/synthesis/2008/*.

Amy Mioduszewski

2008 Grote Reber Medal Awarded to Sandy Weinreb

The 2008 Grote Reber Gold Medal for lifetime innovative contributions to radio astronomy has been awarded to Dr. Sander Weinreb of NASA's Jet Propulsion Laboratory and the California Institute of Technology. Dr. Weinreb is being honored for his pioneering developments of novel techniques and instrumentation over nearly half a century which have helped to define modern radio astronomy.

Weinreb received his Ph.D. degree in electrical engineering from the Massachusetts Institute of Technology in 1963. While he was still a graduate student at MIT,


Sandy Weinreb

he developed the world's first digital autocorrelation spectrometer which he then used to place a new upper limit to the Galactic deuterium to hydrogen ratio, and with Al Barrett, Lit Meeks, and J. C. Henry, he detected the OH ion, which was the first radio observation of an interstellar molecule. His autocorrelation spectrometer technique is now in use at virtually every major radio observatory throughout the world and has been crucial in the subsequent explosive growth of interstellar molecular spectroscopy.

In 1965 Weinreb came to NRAO where he became Head of the Electronics Division and later Assistant Director. During his 23 years at NRAO, he pioneered the use of low noise cryogenically cooled solid state amplifiers in radio astronomy. He was the architect for the electronic systems design for the NRAO Very Large Array in New Mexico and led the group which developed the novel front ends and the data transmission, acquisition, and monitor and control systems for the VLA.

Subsequently Sandy worked at first at Lockheed Martin Laboratories and then at the University of Massachusetts where he developed MMIC amplifiers and other millimeter wave devices. He has also been a Visiting Professor at the University of Virginia. Most recently he has been a Faculty Associate at Caltech and Principal Scientist at JPL where he has continued his work on MMIC devices and played a leading role in the electronics design for a new DSN space tracking array. He has been active in developing wideband feeds and front ends as well as investigating cost effective designs for modest size antennas, all of which will be important for the next generation of radio telescopes such the SKA. In addition he has been working with the Goldstone Apple Valley Radio Telescope (GAVRT) program to develop a 34 m radio telescope at Goldstone for use with schools around the globe.

The 2008 Reber Medal will be presented to Weinreb at the URSI Commission J business meeting to be held in Chicago on August 13. The Reber Medal was established by the Trustees of the Grote Reber Foundation to honor the achievements of Grote Reber and is administered by the Queen Victoria Museum in Launceston, Tasmania in cooperation with NRAO, the University of Tasmania, and the CSIRO Australia Telescope National Facility.

Nominations for the 2008 Medal may be sent to Martin George, Queen Victoria Museum, Wellington St, Launceston, Tasmania 7250, Australia or by e-mail to: *martin@qvmag.tas.gov.au* to be received no later than November 15, 2008.

Ken Kellermann

NRAO Participates in the BEYA Conference

Roy Norville (left) and Gene Cole (right) speak to a BEYA conference participant.

In February, as part of the diversity outreach and recruitment program, staff from the NRAO participated in the National Black Engineer of the Year Award STEM Global Competitiveness Conference (BEYA) held this year in Baltimore, Maryland, which recognizes the ongoing achievements of black leaders in science, technology, engineering, and math-related careers. NRAO was proud to represent the astronomical community and the National Science Foundation at the BEYA Career Fair which focused on linking qualified engineers, scientists, business professionals and students with employers. Roy Norville, Gene Cole, and Amy Shelton talked to a number of interested engineering coop candidates, many from historically black colleges and universities.

Roy Norville is leading the follow-up effort with a number of historically black colleges and universities to match talent from their respective student pools with the NRAO's co-op openings. For more information about the BEYA conference, please visit their website at *http://www.blackengineeroftheyear.org*. The current listing of open NRAO co-op opportunities can be found at *http://www.nrao.edu/students/co-op.shtml*.

Amy Shelton

NRAO Business Managers Meet in Chile

NRAO Business Managers at the ALMA Operations Support Facility site (OSF) in Chile with a VertexRSI antenna.

Last January, the annual National Radio Astronomy Observatory Business Managers' Meeting (BMM) took place in Santiago, Chile, the first time this event has been held outside the United States. As always, this meeting encouraged extensive discussion of the latest NRAO business issues, including budgets, personnel, and site updates. It was also the first major opportunity for many of our business managers to acquire a direct appreciation of what is involved in operating in Chile. This BMM was also an occasion to strengthen the NRAO professional bonds across the equator in the spirit of "One Observatory".

The primary focus for this year's meeting was the ALMA Construction Project and ALMA Operations. The BMM gave each attendee the perfect chance to see on-site the results of their hard work and also to become more aware of the project's complexities. Most of the business and administrative staff had their first opportunity to visit Chile, including the Joint ALMA Observatory (JAO), European Southern Observatory

(ESO), and the ALMA sites. Topics covered at this BMM included: Administration; Fiscal; Management Information Systems; Environment, Safety and Security; Human Resources; Procurement; and Contracts. Also, after visiting the ALMA site, attendees were briefed regarding local issues including ALMA Operations, NRAO/AUI Executive support, hiring, human resources, payroll support, and roles and responsibilities within ALMA. The attending staff gained a much improved understanding of ALMA Construction and Operations, especially with regard to infrastructure and logistics, as well as the complexities associated with running a multi-national Executive team with geographically dispersed office locations. The BMM attendees also gained an improved perspective on the role of the NRAO Chile business office's duties and responsibilities for ALMA Construction and ALMA Operations.

The meeting outlined the "shared" business process approach of providing support in Fiscal, Procurement, Contracts, Accounts Payable, and other areas. These shared systems provide services in a cost-effective, efficient manner. Overall, the impression the NRAO participants brought home was that the Chile Business Office is doing a very good job and displays a strong, customer-focused approach. Finally, but no less importantly, this meeting was a great opportunity for the complete NRAO U.S. business team to become local promoters of the ALMA Project and to experience directly the living conditions future expatriates will experience when moving to Chile, and in particular to Santiago, a modern town with high cosmopolitan living standards, including access to excellent educational, medical, and IT services.

G. H. Clark and S. Cabezón

NRAO Library News

Authors: To answer your questions about page charges, remember to check the NRAO page charge requirements at: *http://www.nrao.edu/library/pagecharges.shtml*.

Thank you! We appreciate the authors who have, upon receipt of a request, sent Proposal Numbers for NRAO telescope observations in their papers. This expands the usefulness of the data.

If you need an NRAO Memo, Technical Report, or other NRAO publication, please contact the Library at: *library@nrao.edu*. We will supply the Memo, Report, or other publication electronically.

FURTHER INFORMATION

Visit the NRAO web site at: *http://www.nrao.edu*

NRAO Contact Information

Headquarters
Director's, Human Resources, Business Offices
Atacama Large Millimeter Array
North American ALMA Science Center
Charlottesville, Virginia
(434) 296-0211

Green Bank Site
Green Bank Telescope
Green Bank, West Virginia
(304) 456-2011

Array Operations Center
Very Large Array
Very Long Baseline Array
Socorro, New Mexico
(575) 835-7000

NRAO/AUI-Chile
Apoquindo 3650, Piso 18
Las Condes
Santiago de Chile
Chile
(56) 2-210-9600

Tucson Site
Tucson, Arizona
(520) 882-8250

NRAO Results

For more information on recent scientific research with NRAO telescopes:

NRAO Press Releases: *http://www.nrao.edu/pr*
Discoveries with the GBT: *http://www.gb.nrao.edu/epo/GBT/data.html*
VLA Observation Highlights: *http://www.vla.nrao.edu/genpub/current_obs/*

NRAO Data and Products

NRAO Data Archive System: *http://e2e.nrao.edu/archive/*
VLA NVSS Survey (VLA D-array 20 cm continuum): *http://www.cv.nrao.edu/nvss/*
VLA FIRST Survey (VLA B-array 20 cm continuum): *http://www.cv.nrao.edu/first/*
Galactic Plane "A" Survey: *http://www.gb.nrao.edu/~glangsto/GPA/*
Green Bank Solar Radio Burst Spectrometer (SRBS): *http://www.nrao.edu/astrores/gbsrbs/*
Essential Radio Astronomy (web-based radio astronomy course):
http://www.cv.nrao.edu/course/astr534/ERA.shtml

Observing Information

VLA: *http://www.vla.nrao.edu/astro*
VLBA: *http://www.vlba.nrao.edu/astro*
GBT: *http://www.gb.nrao.edu/astronomers.shtml*
Information on proposal templates, instructions, and deadlines can be found at:
http://www.nrao.edu/administration/directors_office/

Publicizing NRAO Results

If you have a new research result obtained using an NRAO telescope that might be of interest to a wider audience, please write a 2-3 sentence description of the result and email it to one or more of the persons listed below. Your information could result in a press release, an article in this Newsletter, and/or inclusion of your image in the NRAO Image Gallery.

Press release contact: Dave Finley, Public Information Officer (*dfinley@nrao.edu*)
Newsletter contact: Mark Adams, Editor (*mtadams@nrao.edu*)
Image Gallery contact: Patricia Smiley, Information Services Coordinator (*psmiley@nrao.edu*)

NRAO Page Charge Policy

It is NRAO policy to pay a portion of the page charges for articles reporting original observations made with NRAO instruments or utilizing NRAO archival data. For more information and for details of the policy requirements, please see: *http://www.nrao.edu/library/page_charges.shtml.*

The NRAO Graphics Department will be happy to assist you in the production of images for your article as well as for your research papers. Contact Patricia Smiley (*psmiley@nrao.edu*) with your request.

If you have an interesting new research result obtained using NRAO telescopes that could be featured in the NRAO *Newsletter*, please contact Tim Bastian at *tbastian@nrao.edu*. We particularly encourage Ph.D. students to describe their thesis work.

Editor: Mark T. Adams (*mtadams@nrao.edu*); Science Editor: Tim Bastian (*tbastian@nrao.edu*); Assistant Editor: Ellen Bouton; Layout and Design: Patricia Smiley

The National Radio Astronomy Observatory is a facility of the National Science Foundation operated under cooperative agreement by Associated Universities, Inc.

NATIONAL RADIO ASTRONOMY OBSERVATORY
520 EDGEMONT ROAD
CHARLOTTESVILLE, VA 22903-2475

DATED MATERIAL - DO NOT DELAY