NATIONAL RADIO ASTRONOMY OBSERVATORY

Newsletter

October 2005 Issue 105

The Geometric Distance and Proper Motion of M33

Getting Its Kicks: A VLBA Parallax for the Hyperfast Pulsar B1508+55

North American ALMA Science Center Workshop

ALMA and EVLA Town Meetings at the AAS

Also in this Issue:

Table of Contents

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 Jim Condon at *jcondon@nrao.edu*. We particularly encourage Ph.D. students to describe their thesis work.

Editor: Mark T. Adams (*mtadams@nrao.edu*); Science Editor: Jim Condon (*jcondon@nrao.edu*);
Assistant Editor: Sheila Marks; Layout and Design: Patricia Smiley

Cover Image: This image of the Triangulum Galaxy was created by combining optical data from the 0.9-meter telescope on Kitt Peak in Arizona with radio data from the NRAO's Very Large Array (VLA) telescope in New Mexico and the Westerbork Synthesis Radio Telescope (WSRT) in the Netherlands. Also known as M33, the Triangulum Galaxy is part of the Local Group of galaxies, which includes the Andromeda Galaxy (M31) and our galaxy, the Milky Way. M33 is over thirty thousand light years across, and more than two million light years away.

Investigator(s): Travis Rector, David Thilker and Robert Braun

Fred K. Y. Lo, Director

On Monday, July 11, 2005, the ALMA project achieved a major milestone as the National Science Foundation (NSF) and Associated Universities, Incorporated (AUI) announced that AUI had signed a contract with Vertex Communications Corporation to purchase North America's share of the array's antennas. This contract provides for the purchase of 25 antennas, with options for up to 32 antennas. This milestone was achieved as a result of a long and careful procurement process which included extensive coordination with North America's European partner, the European Southern Observatory (ESO), and with the Joint ALMA Office, which is overseeing construction of the array. NSF's approval followed the recommendation of the ALMA Director and the unanimous concurrence of the ALMA Board, the oversight body for ALMA. This important decision affirms NSF's commitment to this transformational international facility, and its confidence in the ALMA team and partnership. At its June 2005 meeting, the ESO Council reaffirmed its commitment to ALMA, and ESO is working to complete its parallel antenna procurement process as soon as possible. ALMA will be a remarkable international facility that, when completed, will be 100 times more powerful than the present facilities at millimeter and sub-millimeter wavelengths.

Immediately after the January 2006 American Astronomical Society meeting in Washington D.C., the North American ALMA Science Center (NAASC) will host a workshop titled *From z-Machines to ALMA: (Sub)Millimeter Spectroscopy of Galaxies.* In the last decade, deep imaging from infrared through radio wavelengths has revealed important populations of distant, dusty galaxies with high rates of star formation and/or accretion. Multiple efforts are now underway to build dedicated, wide-bandwidth instruments, so-called "*z*-Machines," that can directly determine molecular emission-line redshifts for sources too obscured to be easily studied at optical or infrared wavelengths. With ALMA under construction, it is timely to convene a workshop to: (a) familiarize the astronomical community with the new generation of wide-bandwidth (sub)millimeter spectrometers; (b) highlight the key scientific questions about dusty high-redshift galaxies that can soon be meaningfully addressed; and (c) consider how observing programs can optimize exploitation of ALMA's unique capabilities on longer timescales. This workshop is being hosted by the North American ALMA Science Center, located at the NRAO headquarters in Charlottesville, Virginia. Additional information can be found on-line at *http://www.cv.nrao.edu/naasc/zmachines/*.

The Senior Review being conducted by the National Science Foundation's Division of Astronomical Sciences (NSF-AST) is another very important on-going activity. The NRAO submitted its report to the NSF Senior Review on July 31, 2005. The report was carefully prepared by the Observatory's staff with input from a cross-section of the astronomical community, and is available on-line at *http://www.nrao.edu*. The NSF-AST Senior Review seeks to identify $30M of annual funding within the AST Division that would be reallocated by 2011 to fund the design and development of future high-priority projects such as the Giant Segmented Mirror Telescope, the Large Synoptic Survey Telescope, and the operation of ALMA. Guided by the Senior Review, the NSF will make important decisions regarding the selective reduction of current federally-funded facilities so that new initiatives can be funded. Community involvement is absolutely crucial to assess whether the proposed changes lead to a vital, sustainable future for astronomy, or whether they demand a pace and scope of change that is too drastic.

The NRAO currently operates a system of complementary centimeter-wavelength radio telescopes — the Robert C. Byrd Green Bank Telescope, the Very Large Array, the Very Long Baseline Array — and the Central Development Laboratory. In addition to its role in ALMA, the NRAO is building Phase I of the

Expanded Very Large Array (EVLA), replacing the VLA by a new facility which has ten times the sensitivity and 1000 times the spectral capability.

In 2011, the NRAO will be the premier radio observatory providing the astronomy community a suite of powerful, complementary telescopes that will form the "radio cornerstone" of a system of world-class international astronomical facilities that span the radio, optical-infrared, X-ray, and gamma-ray wavelength regions. NRAO facilities will enable astronomers to directly observe the formation of stars and planetary systems, the first galaxies and active galactic nuclei, and to address many issues at the frontiers of physics via astronomical observations. The exceptional breadth and depth of the NRAO's facilities, and the Observatory's expertise and experience in radio-astronomical science and technology, have taken 50 years to build, resulting in a NRAO that is recognized by many as an essential resource for astronomy in the United States and, indeed, in the world.

A Senior Review of the facilities supported by the NSF - AST is a necessary process to evaluate the costs and benefits of these facilities, and to prioritize spending, especially since worthwhile new projects are awaiting funding. However, care must be taken to avoid irreparable damage to the existing U.S. astronomy infrastructure. The balance between supporting the existing facilities that give U.S. astronomy a competitive advantage and initiating new projects that will maintain that competitive position is a very delicate one.

Your input to the NRAO and the NSF-AST Senior Review is extremely important. Please e-mail your comments and feedback to *senreview@nrao.edu*. I look forward to hearing from you.

Finally, the astronomical community has repeatedly demonstrated its strong support for observing programs characterized by broad community interest, immediate and lasting scientific importance, and rapid, non-proprietary data release, i.e., Legacy Science Programs. Based on input and feedback from the Users Committee and the Visiting Committee, NRAO has begun to consider whether and how Legacy Science Programs might be implemented at the Observatory's existing (VLA, VLBA, GBT) and future research facilities (ALMA, EVLA). Legacy programs have been very successfully implemented at the Hubble Space Telescope, the Spitzer Space Telescope, and other observatories. These programs have enabled excellent science and engaged numerous researchers in the astronomical community. The NRAO will be actively soliciting your input about possible Legacy Science Program implementations at the Observatory, in particular, through workshops that will be organized in the next few months.

Please be assured that every action and decision taken by myself and the NRAO management and technical staff seeks to improve the services and science delivered by the Observatory to the astronomical community. The NRAO sees the challenges of the present as necessary steps towards the scientific opportunities of the future. The Observatory's people are proud of what they have accomplished, and confident of their ability to continue to design, operate, and maintain the facilities demanded by the extraordinary enterprise that is modern astronomy.

Fred K.Y. Lo
Director

Science

The Geometric Distance and Proper Motion of M33

The closest places to look for dark-matter halos are the environments of the Milky Way and the Andromeda galaxy (M31) in the Local Group. Various attempts have been made to "weigh" the galaxies in the Local Group, especially the Milky Way and its not very prominent dark-matter halo (Kulessa & Lynden Bell 1992; Kochanek 1996). So far it has only been possible to use statistical approaches based on line-of-sight velocities to derive its gravitational potential. Clearly, the most reliable way of deriving masses is using orbits, which requires the knowledge of three-dimensional velocity vectors obtained from measurements of proper motions.

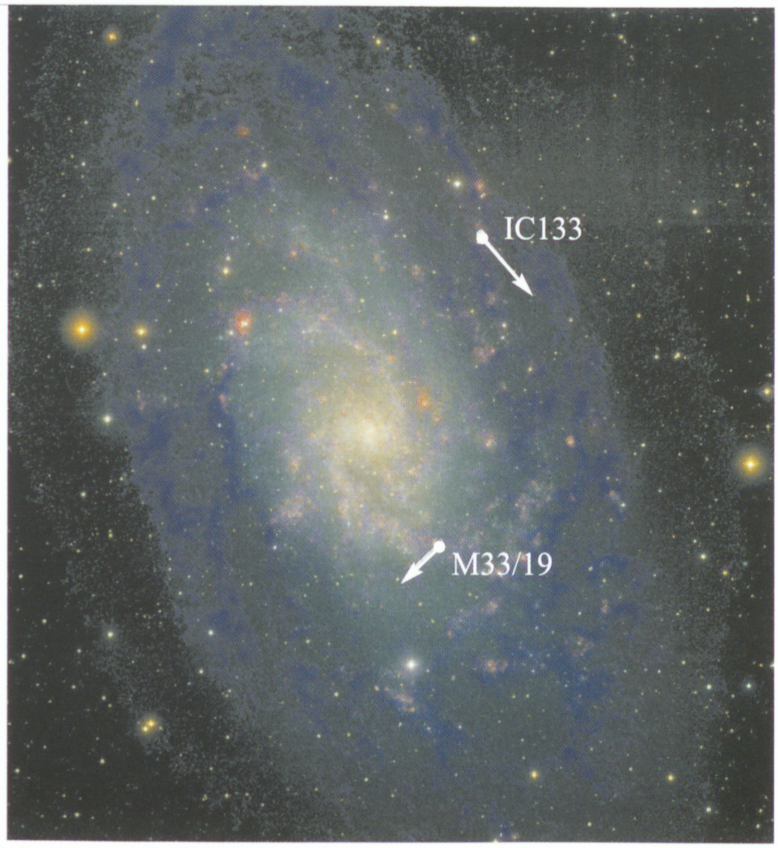


Figure 1. Positions and motions of the two water-vapor maser in M33. Credit: Travis Rector (NRAO/AUI/NSF and NOAO/AURA/NSF), David Thilker (NRAO/AUI/NSF), and Robert Braun (ASTRON).

Measuring proper motions of galaxies is very difficult since a galaxy at 700 kpc distance with a transverse speed of 100 km s^{-1} would appear to move only 0.03 mas/yr (milliarcsec per year) on the sky. Schweitzer et al. (1995) claim a motion of 0.56 ± 0.25 mas/yr for the Sculptor dwarf spheroidal galaxy from plates spanning 50 years in time. More recently, the Hubble Space Telescope was used to measure proper motions of a few companion galaxies of the Milky Way (e.g. Piatek et al. 2002). However, such measurements by optical telescopes are limited to the closest companions of the Milky Way.

The very high resolution and astrometric accuracy of the Very Long Baseline Array using the phase-referencing technique allowed us to measure the proper motions of two bright maser sources in M33, a galaxy in the Andromeda subgroup (Brunthaler et al. 2005). The very small relative motion (only 0.031 mas/yr) of the two maser sources—IC 133 located in the north and M33/19 in the south of the galaxy disk (Figure 1)—is caused by the rotation of M33. Knowing the rotation curve and inclination of the galactic disk from HI observations (Corbelli & Schneider 1997), one can predict the relative angular motion of the two masing regions as a function of distance from us. By comparing the predicted relative motion with the observed motion, one gets a geometric distance of $730 \pm 100 \pm 135$ kpc, where the first error indicates the statistical error from the proper-motion measurements and the second error is the systematic error from the rotation model. This distance is consistent with recent estimates using Cepheids (Lee et al. 2002) and the tip of the red-giant branch (McConnachie et al. 2004).

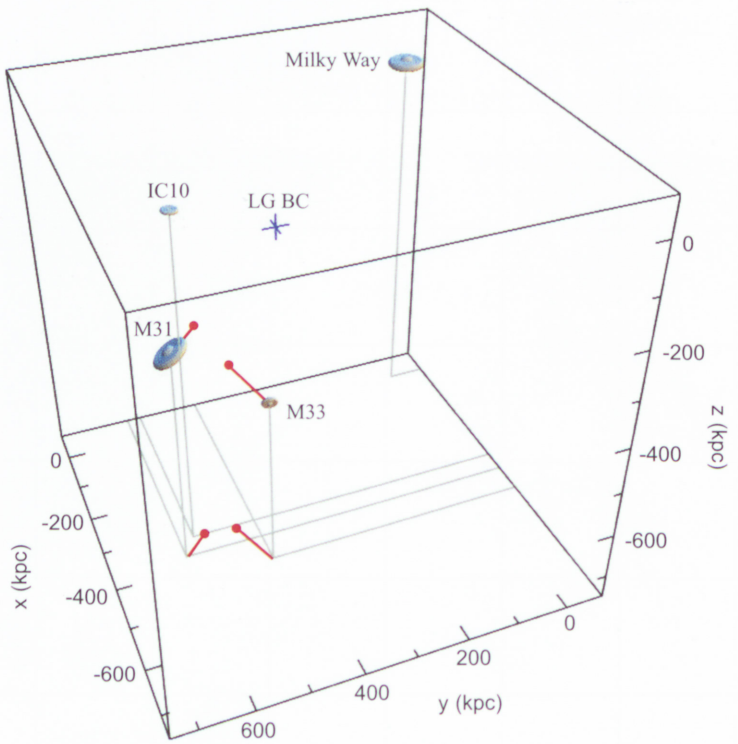


Figure 2. Schematic view of the Local Group with the space velocity of M33 and the radial velocity of M31. The blue cross marks the position of the Local Group Barycenter (LG BC) (Taken from Brunthaler et al. 2005).

Since the measurements were made relative to an extragalactic background source, the proper motion of M33 as a whole could also be measured. After correcting for the rotation of M33 and the Sun's motion in the Milky Way, one gets proper motions of -101 ± 35 km s^{-1} in right ascension and 156 ± 47 km s^{-1} in declination. Together with the systemic radial velocity of -39 ± 9 km s^{-1}, this gives the three-dimensional velocity vector of M33 relative to the Milky Way. The results show that the galaxy M33 moves at a speed of 190 ± 59 km s^{-1} relative to the Milky Way in a direction toward the Andromeda galaxy (Figure 2).

An important but still missing parameter is the proper motion of the Andromeda galaxy (M31). However, computer (n-body) simulations of the M31 – M33 system show that certain proper motions of M31 would have led to a very close interaction between M31 and M33 in the past (Loeb et al. 2005). These close tidal interactions would have destroyed or disturbed the stellar disk of M33. Hence, proper-motion values of M31 that would lead to these close interactions can be excluded. The condition that M33's stellar disk was not tidally disrupted by either M31 or the Milky Way over the past 10 billion years favors a proper-motion amplitude of 100 ± 20 km s^{-1} for M31 (Figure 3). This assumes a standard model for the dark-matter halos of spiral galaxies. If there is less dark matter, then a lower proper motion for M31 is indicated.

Today we are only able to study the extreme (bright) tip of the maser luminosity distribution for interstellar masers. The Square Kilometer Array (SKA), with substantial collecting area on intercontinental baselines and frequency coverage up to 22 GHz (Fomalont & Reid 2004), will provide the necessary sensitivity to

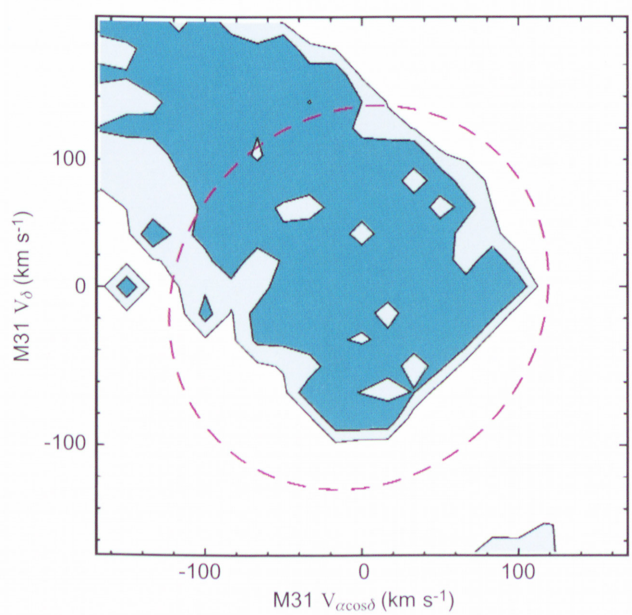


Figure 3. The fraction of tidally stripped stars as a function of the trial proper motion of M31. Trial proper motions are in equatorial coordinates (right ascension α and declination δ). Contours delineate 20 percent (light blue) and 50 percent (dark blue) of the total number of stars stripped in the simulation. Regions inside the dashed ellipses correspond to trial proper motions that satisfy the condition that the separation between M31 and the Milky Way was smaller 10 Gyr ago than it is today (the "timing" argument). (Taken from Loeb et al. 2005).

detect and measure the proper motions of a much greater number of masers in active star-forming regions in the Local Group. Direct measurements of the proper motion of M31 and other Local Group galaxies would allow one to better constrain the distribution of dark matter and to calculate both the history and fate of the these galaxies.

A. Brunthaler (Max-Planck-Institut für Radioastronomie) and M. Reid (CfA)

References :

Brunthaler et al. 2005, Science, 304, 1440
Corbelli & Schneider 1997, ApJ, 479, 244
Fomalont & Reid 2004, NewAR, 48, 1473
Kochanek 1996, ApJ, 457, 228
Kulessa & Lynden Bell 1992, MNRAS, 255, 105
Lee et al. 2002, ApJ, 565, 959
Loeb et al. 2005, ApJ, in press, astro-ph/0506609
McConnachie et al. 2004, MNRAS, 350, 243
Piatek et al. 2002, AJ, 124, 3198
Schweitzer et al. 1995, ApJ, 110, 2747

Getting Its Kicks: A VLBA Parallax for the Hyperfast Pulsar B1508+55

The end of the life of a massive star is marked by the rapid collapse of its core to nuclear densities, a supernova explosion, and possibly the birth of a neutron star. It is natural to expect that a small degree of asymmetry in the core-collapse process would provide a kick to the nascent neutron star, imparting a high velocity. The highest observed neutron-star velocities thus set a minimum degree of asymmetry required in supernovae and impose stringent constraints on simulations of core collapse.

It has been apparent almost since their discovery that young radio pulsars do indeed have higher velocities than their progenitor stellar populations. For example, pulsars have larger Galactic scale heights than their progenitors and higher measured proper motions and, in some cases, show spectacular bow-shock nebulae as they move supersonically through the interstellar medium. However, the current pulsar-velocity distribution suffers from severe selection effects since the highest-velocity pulsars spend the least time within our detection volume, which is centered on our location within the Galactic plane. The velocity distribution is also uncertain since most pulsar distances (and hence velocities) are inferred from their pulse dispersion through models of the Galactic electron-density distribution.

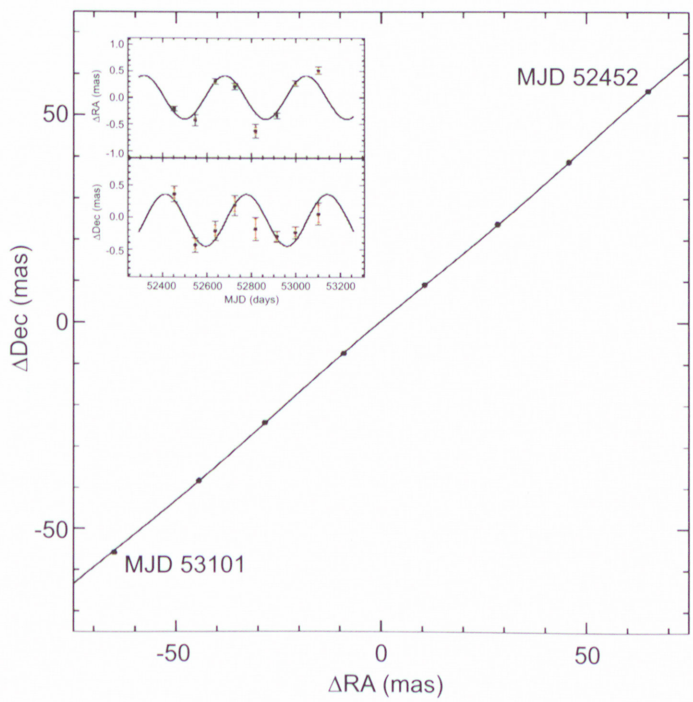


Figure 1. The motion of PSR B1508+55 in right ascension and declination, with the best fit proper-motion and parallax model overplotted. The error estimates for the proper-motion data points are smaller than the size of the points. Inset: The parallax signature of B1508+55 in right ascension and declination, after subtracting the best-fit proper motion from the astrometric positions. Curves corresponding to the best-fit parallax $\pi = 0.415$ mas are overplotted.

Model-independent distances and velocities can be obtained from high-precision astrometry, which yields proper-motion and parallax measurements. The instrument of choice for such projects is the Very Long Baseline Array (VLBA), which can attain the sub-milliarcsecond accuracy required to measure kiloparsec distances. In a recently concluded VLBA program, 27 pulsars were observed for 8 epochs each, spanning two years and utilizing over 500 hours of VLBA observing time in total. The observations at 1.4–1.7 GHz were phase-referenced by nodding between the target and a nearby calibrator, and in most cases a faint extragalactic source within the same primary beam as the target pulsar was used to further refine the phase referencing. As a result of this project, the number of measured pulsars parallaxes is expected to more than double.

One of the most interesting measurements to emerge from the project is the distance and velocity of the pulsar B1508+55, whose proper motion and parallax are shown in Figure 1. We find a proper motion $\mu_\alpha = -73.606 \pm 0.044$ mas yr^{-1}, $\mu_\delta = -62.622 \pm 0.088$ mas yr^{-1}, and a parallax $\pi = 0.415 \pm 0.037$ mas, leading to model-independent estimates of its distance ($2.37^{+0.23}_{-0.20}$) kpc and transverse velocity (1083^{+103}_{-90} km s^{-1}), the *highest velocity directly measured* for a neutron star (Chatterjee et al. 2005).

B1508+55 is presently about 2 kpc above the Galactic plane, but its proper-motion vector suggests a birth site in the plane itself, as shown in Figure 2. The characteristic (spindown) age of the pulsar is 2.34 Myr. Tracing the pulsar back in the Galactic gravitational potential, we find that a pulsar of that age could have been born within 200 pc of the plane (for a modest range in the unknown radial velocity, between 0–300 km s^{-1}). The pulsar appears to have been born in or around the Cygnus OB associations with a velocity ~ 1100 km s^{-1} and is moving rapidly away from the Galactic plane, on course to irrevocably escape the Galaxy.

What does such a high birth velocity imply? Binary disruption by itself is unlikely to impart such a high velocity (Iben & Tutukov 1996) and a natal kick is indicated. In simulations, a natal kick of the correct order of magnitude has been obtained from hydrodynamic and convective instabilities (Burrows & Hayes 1996; Janka & Mueller 1996), and more exotic mechanisms involving asymmetric neutrino emission in the presence of strong magnetic fields (B > 10^{15} G) have also been suggested (Arras & Lai 1999).

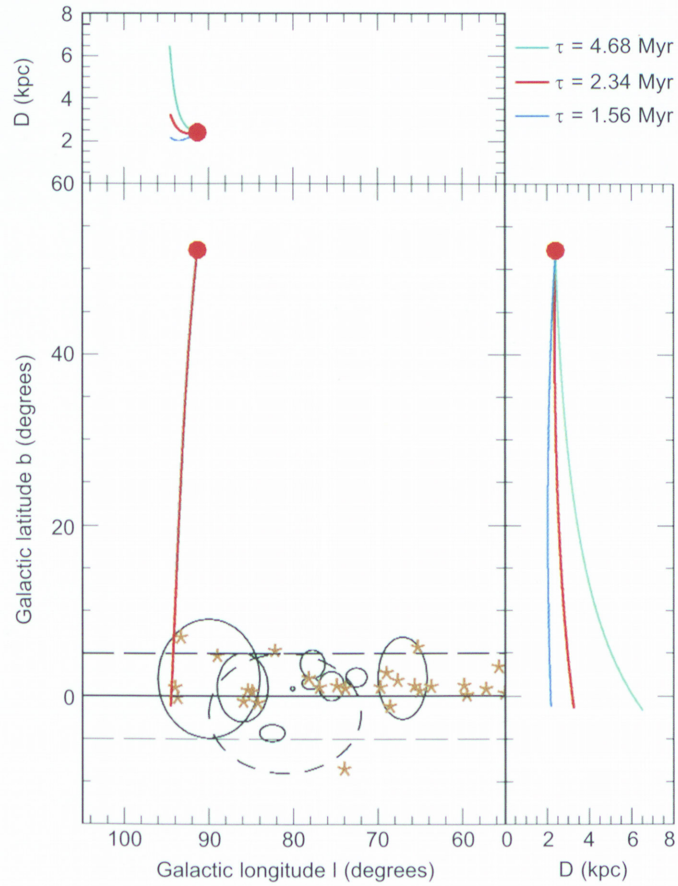


Figure 2. Possible orbits for B1508+55, traced back in the Galactic potential. The solid red dot denotes the current pulsar position and the red line the path it has followed for an age $\tau = 2.34$ Myr (the spindown age, with braking index $n = 3$) and a radial velocity $v_r = 200$ km s^{-1}. Other possible orbits are shown (green lines) for $\tau = 4.68$ Myr (i.e., $n = 2$ for a small initial birth period) with corresponding $v_r = -300$ km s^{-1}, and blue for $\tau = 1.56$ Myr ($n = 4$) with $v_r = 700$km s^{-1}. Also indicated are the Cygnus superbubble (2 kpc away, dashed ellipse) and the Cygnus OB associations (solid ellipses). The starred symbols are the Galactic supernova remnants identified in this region, the solid horizontal line is the Galactic plane, and the horizontal dashed lines indicate the pulsar birth scale height at the distance of the Cygnus superbubble.

However, the first full three-dimensional simulations of core collapse (Fryer 2004) have trouble producing kicks of this magnitude. It is possible that current simulations are incomplete, or that neutrino-driven kicks are implicated, or possibly that binary disruption and a natal kick acted in concert to provide B1508+55 its high velocity.

Ongoing deep pulsar searches, and especially searches at high Galactic latitudes, coupled with long-term VLBA astrometry programs are likely to discover additional high-velocity pulsars and continue to elucidate the velocity distribution and birth circumstances of neutron stars.

S. Chatterjee (NRAO and Harvard-Smithsonian)
W. H. T. Vlemmings (Jodrell Bank Observatory and Cornell University)

References:

Arras, P., & Lai, D., 1999, ApJ, 519, 745

Burrows, A., & Hayes, J., 1996, Physical Review Letters, 76, 352

Chatterjee, S., Vlemmings, W. H. T., Brisken, W. F., Laxio, T. J. W., Cordes, J. M., Goss, W. M., Thorsett, S. E., Fomalont, E. B., Lyne, A. G., & Kramer, M., 2005, ApJ, 630 L61

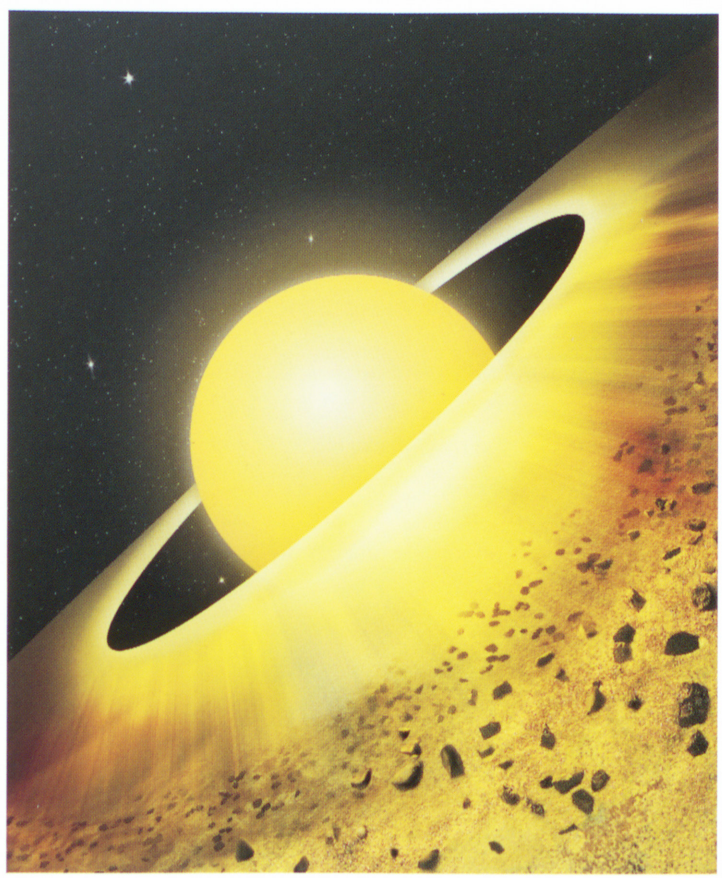
Fryer, C. L., 2004, ApJ, 601, L175

Iben, I. J., & Tutukov, A. V., 1996, ApJ 456, 738

Janka, H. T., & Mueller, E., 1996, A&A, 306, 167

Scheck, L., Plewa, T., Janka, H. T., Kifonidis, K., & Muller, E., 2004, Physical Review Letters, 92, 011103

Artist's concept of the dusty disk surrounding TW Hydrae.



Astronomer David Wilner of the Harvard-Smithsonian Center for Astrophysics (CfA) and his colleagues have discovered that the gaseous protoplanetary disk surrounding TW Hydrae holds vast swaths of pebbles extending outward for at least 1 billion miles. These rocky chunks should continue to grow in size as they collide and stick together until they eventually form planets.

See the entire NRAO Press Release at *http://www.nrao.edu/pr/2005/twhydrae/*

Image credit: Bill Saxton, NRAO/AUI/NSF

Atacama Large Millimeter Array

Upcoming NAASC ALMA Workshop From *z*-Machines to ALMA: (Sub)millimeter Spectroscopy of Galaxies

On January 13-14, 2006, the North American ALMA Science Center at NRAO will sponsor a workshop in Charlottesville, Virginia on (sub)millimeter spectroscopy of high-redshift galaxies. In the last decade, deep imaging from infrared through radio wavelengths has revealed important populations of distant, dusty galaxies with high rates of star formation and/or accretion. Multiple efforts are now underway to build dedicated, wide-bandwidth instruments ("*z*-Machines") that can directly determine molecular emission-line redshifts for sources too obscured to be easily studied at short wavelengths. With ALMA now under construction, it is timely to convene a workshop whose goals are to:

- familiarize the community with the new generation of wide-bandwidth (sub)millimeter spectrometers,
- highlight the key scientific questions about dusty high-redshift galaxies that *z*-machines will be able to address in the near term, and
- consider how observing programs with *z*-machines can optimize exploitation of ALMA's unique capabilities on longer timescales.

Serving on the Scientific Organizing Committee are Andrew Baker (chair, NRAO/University of Maryland), Andrew Blain (Caltech), Neal Erickson (University of Massachusetts), Xiaohui Fan (University of Arizona), Jason Glenn (University of Colorado), Eduardo Hardy (NRAO), Andrew Harris (University of Maryland), Gordon Stacey (Cornell), Paul Vanden Bout (NRAO), and Min Yun (University of Massachusetts). John Hibbard is chairing the Local Organizing Committee. The first announcement, a list of confirmed speakers, and web forms for preregistration and abstract submission are available at *http://www.cv.nrao.edu/naasc/zmachines/*. Students are especially encouraged to attend. We look forward to seeing you there!

A. Baker, J. Hibbard, and P. Vanden Bout

ALMA Town Meeting

ALMA will hold a Town Meeting at the January meeting of the American Astronomical Society, to be held January 8-12, 2006 in Washington, D.C. The purpose of this Town Meeting is to inform the membership of the status of the ALMA Project. By the time of the AAS meeting in Washington, the production antenna contract will have been let, and construction in Chile will have advanced substantially. Further, the North American ALMA Science Center (NAASC) will have begun initial operations in preparation for ALMA Early Science. At this Town Meeting, the progress of ALMA construction and plans for the NAASC and Early Science will be presented, with ample time allocated for answering questions from the audience.

The January AAS meeting will also feature special sessions for the Herschel Space Observatory and the Submillimeter Array (SMA). These should be of great interest to all potential ALMA users, too.

Alwyn Wootten

ALMA Antenna Contract Signed

The National Science Foundation (NSF) and Associated Universities, Incorporated (AUI), which operates the National Radio Astronomy Observatory for the National Science Foundation, are pleased to announce that on July 11, 2005 AUI signed a contract with Vertex Communications Corporation to purchase up to 32 antennas for the Atacama Large Millimeter Array (ALMA).

Figure 1. The VertexRSI antenna, a prototype for the ALMA production antennas, has undergone extensive testing at the ALMA Test Facility (ATF) at the Very Large Array (VLA) site near Socorro, NM.

Figure 2. General Dynamics C4 Systems Senior Vice President Chris Marzilli and NRAO Director Fred K.Y. Lo sign the contract for the production ALMA antennas.

NSF authorized AUI to negotiate and sign a contract to purchase North America's share of the ALMA antennas following a long and careful procurement process which included extensive coordination with North America's European partner, the European Southern Observatory (ESO), and with the Joint ALMA Office (JAO), which is overseeing construction of the array.

The prototype antennas have been thoroughly tested to determine their worthiness for ALMA and to fine tune procedures for testing the production antennas, the first of which is expected to arrive in Chile in early 2007. As part of its contribution to ALMA, Japan has signed a contract for four 12m antennas, a component of the Atacama Compact Array. These antennas are also expected to arrive at the ALMA site in 2007. The prototype antennas, now at the ALMA Test Facility (ATF) at the VLA site, will undergo several changes as the

Figure 3. During August, each of the new antenna stations in the newly designed innter configuration was staked by an on-site team. Problems were reported back to Conway, who then implemented small changes to perfect array performance. Here, station 136 is staked.

year winds down. The Japanese prototype will return to Japan for refurbishing and eventual shipment to Chile. The remaining two prototypes will be used as a testbed for ALMA equipment and procedures; they will be re-equipped as a one-baseline interferometer over the coming months.

Meanwhile, the site in Chile will be prepared to receive the telescopes and the signals from them. The ALMA configuration has been redesigned by John Conway and Mark Holdaway to provide excellent imaging on fewer antenna stations than were previously employed in the design. Careful attention was paid to the imaging properties of intermediate arrays; the new design should provide excellent imaging characteristics for either a 50 or 64 antenna array.

Alwyn Wootten

AOS Technical Building Construction to Begin

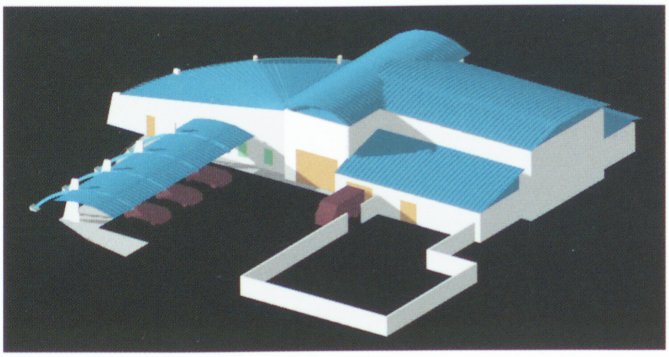


Figure 1. Artist's concept of the technical building to be constructed at Array Operations Site (AOS).

Figure 2. The signing of the foundation and shell packages for the AOS technical building took place with (right to left): Eduardo Hardy, AUI Representative in Chile, Gerardo Palma, Managing Director of CON PAX, and Mauricio Pilleux, AUI Business Manager in Chile.

The major ALMA facility at the 16,000 foot level on Chajnantor is the ALMA Array Operations Site (AOS) technical building, which houses the ALMA correlator, the Atacama Compact Array correlator, local oscillator elements and other electronics. From here the correlated signals are sent, along with other data, to the Operations Support Facility, several tens of kilometers distant at an elevation just below 10,000 feet, where they are archived and undergo first analysis.

On August 2, the contracts for the foundation and shell packages for the AOS technical building were signed at the NRAO/AUI offices in Santiago with Chilean company CON PAX. Mobilization is underway and construction is scheduled to start on September 20, 2005. The foundations are scheduled to be completed on December 20, 2005, and the shell structure is scheduled to be finished on March 20, 2006. This work will mark the beginning of construction for ALMA on the high-elevation site.

Alwyn Wootten

North American ALMA Science Center

The North American ALMA Science Center (NAASC) is located in the Edgemont Road building in Charlottesville, Virginia.

The North American ALMA Science Center (NAASC) is located in the Edgemont Road building in Charlottesville, VA. It is the regional contact point between the North American ALMA community and the ALMA project.

An application was filed with the American Astronomical Society (AAS) for a Town Meeting at the Washington D.C. meeting of the Society, January 8-12, 2006. That application has been approved. The 2006 summer meeting of the AAS will be held in Calgary, Canada, with the first day a joint meeting with the Canadian Astronomical Society (CASCA). We are planning a Special Session on ALMA for that day, with colleagues in Canada taking the lead.

The ALMA North American Science Advisory Committee (ANASAC) is composed of representatives of the wider North American astronomical community who provide scientific advice on the operation of the NAASC. The ANASAC met several times over the summer, in a telecon on April 29, 2005, at a face-to-face meeting at the Center for Astrophysics, Harvard University, on June 12, 2005, and in a telecon on August 26, 2005. The committee discussed the scientific impact of various ALMA design considerations, gave input into the antennae procurement process, and took the lead in scheduling the first North American ALMA Workshop – *From z-Machines to ALMA: (Sub)Millimeter Spectroscopy of Galaxies*. At the face-to-face meeting in Cambridge, the ANASAC elected Richard (Dick) Crutcher (University of Illinois) as their new Chair. Dick takes over these duties from Min Yun (University of Massachusetts), who deserves our thanks for his hard work as the original ANASAC Chair. The next ANASAC telecon is scheduled for October 28, 2005. A listing of the ANASAC membership and scheduled meetings is given at *http://www.cv.nrao.edu/naasc/admin.shtml*.

The NAASC staff continues to make progress preparing for ALMA's operational phase, including work on the organizational and staffing plan and by participating in tests of critical ALMA elements, such as the proposal tool, the pipeline system and the off-line data reduction software. Progress has started on developing a spectral line database for use with the ALMA observing tools. More information on the NAASC is available at *http://www.cv.nrao.edu/naasc/*.

Paul Vanden Bout

Socorro

Expanded Very Large Array

Phase I

Phase I of the EVLA Project is now in the middle of the critical phase of testing the final designs of EVLA electronics, and incorporating the converted EVLA antennas into the VLA for continued scientific observing. We describe below the major recent progress in several categories.

EVLA Antennas

There are now four VLA antennas that are undergoing the conversion process to become EVLA antennas. This conversion is a major effort over many weeks, requiring removal of all existing feeds, receivers and electronics, followed by construction of the new cassegrain feed housing and installation of the new feeds, receivers, and associated electronics, plus the new fiber optic Digital Transmission System. Figures 1 and 2 show the new electronics racks located in the vertex room and the arrangement of feeds around the cassegrain feed ring.

Figure 2. The EVLA cassegrain feeds, as labeled. The frequency ranges of each band are described in the receiver status portion of this article.

Figure 1. The EVLA electronics racks, located in the antenna vertex room. The large white object on the left is the bottom end of the new L-band horn.

The current status of the four EVLA antennas is described below.

Antenna 13, the prototype EVLA Test Antenna, has now been withdrawn from service to upgrade its electronics to the final design. It is expected that this installation will be completed, and the antenna returned for testing in September. Antennas 14 and 16 have been outfitted with the final design electronic equipment, and are undergoing tests to ensure adequate performance with all four IFs at all observing bands. Antenna 18 is currently in the antenna barn, undergoing its retrofit. It will be moved in late August into the array to receive its complement of EVLA electronics, and is expected to be ready for testing in October.

Current plans call for converting four more VLA antennas in 2006, after which the rate rises to five per year until the process is completed in 2010. The receiver implementation lags the antenna conversion process, and the full receiver complement for all antennas will not be available until the end of 2012.

Receivers

When completed, the EVLA will operate with eight cassegrain frequency bands, spanning the entire frequency range from 1 to 50 GHz. However, the design and installation of all these receivers is a long process which necessarily lags the antenna conversion process, and will not be completed until the end of the project in 2012.

The eight antennas which will be converted to EVLA standards this year and next will be outfitted with five of the six current VLA Cassegrain bands: L, C, X, K, and Q, as well as the two existing prime-focus low frequency bands. Details for each band follow.

L-band (1.2 – 2 GHz): The new horn and receiver will be available on each antenna, but the orthomode transducer (OMT), required for wide-band tuning capability will not be available until next year. Until then, the available tuning range will be limited by the existing polarizer to the current range of the VLA antennas, 1.25 – 1.7 GHz.

S-band (2 – 4 GHz): Design of this new EVLA capability will begin next year, with testing in 2007, and installation of operational receivers on the array will begin in 2008.

C-band (4 – 8 GHz): The situation is similar to L-band, as this band will use a scaled version of the L-band OMT. Until its implementation next year, the tuning range is the same as that of the VLA: 4.5 – 5.0 GHz.

X-band (8 – 12 GHz): The converted antennas will employ the same X-band feeds and receivers as the VLA until installation of the new wideband feed/receivers starting in 2010. No change in system performance is anticipated until then, so tuning is limited to the current 8.1 – 8.8 GHz.

U-band (12 – 18 GHz): This band will not be available on the EVLA antennas until later in the project. Current plans call for prototyping to begin in 2007, with implementation starting in 2010.

K-band (18 – 26 GHz): The EVLA K-band systems are the same as the VLA's, which were upgraded to modern full-bandwidth, high-sensitivity capability some years ago. Unlike the VLA antennas, which can not utilize the full frequency range due to LO limitations, the EVLA K-band systems will have the full 18 – 26 GHz tuning capability.

Ka-band (26 – 40 GHz): The new feed has been tested on the antenna range, and the prototype receiver is expected to be ready for testing in January 2006, with implementation of the new systems beginning later that year.

Q-band (40 – 50 GHz): The feed and receiver are unchanged from the existing VLA systems.

See ***Utilizing the EVLA's Wideband Capabil-ities*** for a description of the number of available EVLA antennas for wideband observing as a function of band and time.

Correlator

The new EVLA correlator is being designed and built by our Canadian Partners, the Herzberg Institute of Astrophysics (HIA) at the Dominion Radio Astrophysical Observatory (DRAO) near Penticton, British Columbia. They held a critical design review (CDR) for the correlator chip in January 2005, and the contract for chip fabrication was awarded. About 200 prototype correlator chips are expected for delivery in November 2005 for performance testing.

A preliminary design review (PDR) of the entire correlator was held in July 2005. Designs are complete for the station board, which prepares antenna signals for correlation by filtering and delaying the signals, and the baseline board, where correlation is performed.

A prototype 4-antenna correlator, providing up to 2 GHz bandwidth (in one polarization, 1 GHz for dual polarization) with a total of 1024 spectral channels, will undergo on-sky testing with EVLA antennas in early 2007. The initial part of the final correlator—providing more bandwidth on more antennas—will arrive in 2009. Plans for commissioning the new correlator are being reviewed at this time.

The architecture of the correlator software system has been developed. It includes implementation designs for the master correlator control computer, hardware and software interfaces, graphical user interfaces, and the correlator backend system.

The new correlator is a very large digital machine which will radiate copiously in the EVLA's operational bands, and thus must be housed within a RFI-shielded chamber to prevent these emissions from reaching the antennas. As the VLA correlator's RFI chamber is too small for the new correlator, a new 2300 sq. ft. chamber will be located in the large room on the east side of the VLA Control Room. This room is familiar to long-time VLA observers as the former location of the Modcomps, Dec-10, PDP40s, the VLA tape archive, and many other things.

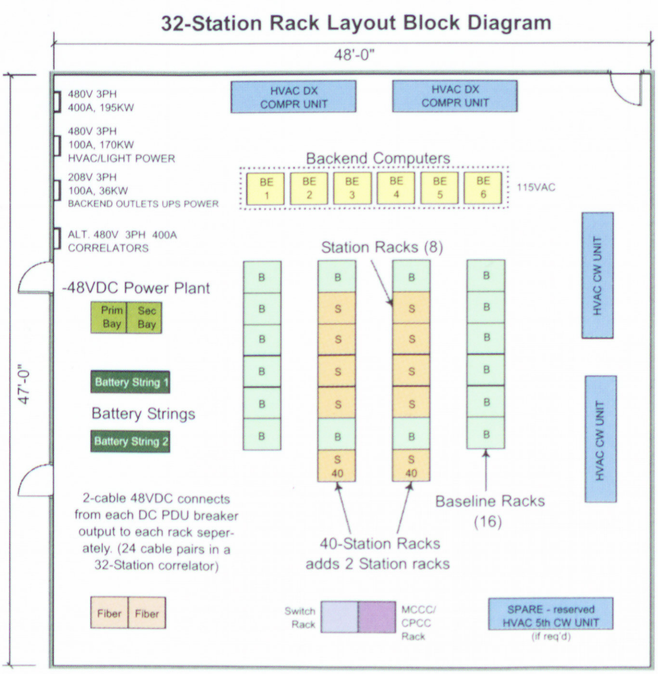


Figure 3. Planned layout for the EVLA correlator and its accompanying hardware within the RFI shielded chamber located in the large room east of the existing operations area. In this figure, the windows looking out onto the array are at the top, and the operations room is on the upper left.

Preparation for the new RFI shielded chamber has proceeded ahead of schedule. The large room has been prepared and a contract has been awarded for the chamber, with installation scheduled to start in September 2005. Figure 3 shows the layout planned by the HIA for the correlator within the chamber.

Software

The EVLA software effort can be separated into two broad categories: transition software and EVLA software. The transition software is needed to control the EVLA antennas while the Modcomps are still being used to control the VLA antennas and current correlator. When the Modcomps are retired—currently planned for mid-2006—transition software will be used by the EVLA Monitor and Control system to run the remaining VLA antennas.

While some work on the final EVLA software has been ongoing, we have been focusing on the transition software. By the time EVLA antennas are returned to regular observing, we will have software in place that will take as input a normal VLA OBSERVE file and use it to control the EVLA antennas for most of the existing observing modes. Some more esoteric modes will not be supported, and some others may require a slight change in observing strategy. Observers that are affected by these limitations will be notified well in advance, and staff help will be available to solve potential problems.

Another major area of effort is in algorithm development for post-processing. AIPS++ has been incorporating EVLA algorithm development into its overall plan for more than a year now, with the goal of being able to reduce EVLA data with sophisticated new data reduction algorithms by the time data are being produced by the new correlator—probably late in 2009.

The first piece of this development was the "W-projection" algorithm for wide-field imaging (see EVLA Memo 67), which was implemented and tested rigorously during this past summer. Further algorithm advances that will be implemented and tested over the next year include pointing correction (see EVLA

Memo 84), full-beam polarization corrections, auto-flagging, and the beginnings of RFI detection and excision. In addition, we are keeping a close eye on world-wide developments in wide-field imaging, such as “peeling”. A new group, the NRAO Algorithm Working Group, or NAWG, has been organized to specifically target algorithm development. This group meets monthly, and participation by outside individuals is welcome. If interested, contact Steve Myers at *smyers@nrao.edu.*

Transition Mode Observing

A requirement for the EVLA Project is that the VLA's observational capabilities be minimally impacted. This means that not only must the ongoing operations of the diminishing number of VLA antennas be maintained, but also that the increasing number of EVLA antennas have the necessary hardware and software to enable their use within the VLA. The inclusion of EVLA antennas within the VLA is termed ‘Transition Mode Observing’.

As noted above, there are currently four antennas out of service, leaving 24 available for ongoing observing. This will shortly be reduced to 23, as antenna 12 will be in the barn for regular maintenance. However, we expect that two of the four will be available for inclusion with the VLA, and operational at all current bands except U-band, at the end of this year, and that all four will be available early in 2006.

After the current phase of intensive testing of the electronics and necessary software is completed next year, we anticipate at least 25 antennas will be available for ongoing observing, except when special EVLA tests require some or all EVLA antennas in a specific subarray.

Utilizing the EVLA's Wideband Capabilities

The EVLA antennas will in general have considerably greater tuning capability than the VLA antennas, and this capability will be available to users willing to put the EVLA antennas into a separate subarray. There will be four EVLA antennas at the end of this year, eight by the end of 2006, and five more each year following until the antenna conversion is completed in 2010.

However, as described above, not all EVLA antennas will be capable of wideband tuning in L and C bands, due to slow development of the necessary wideband polarizer. This situation will be corrected as the new polarizers are available.

The table below lists the planned number of operational EVLA antennas which will be able to provide wide-band tuning at the beginning of each year.

Year	L	S	C	X	U	K	Ka	Q
2006	0	0	0	0	0	4	0	4
2007	3	1	2	0	0	8	3	8
2008	9	1	9	0	1	13	9	13
2009	16	4	16	0	1	18	15	18
2010	22	7	23	0	1	23	21	23
2011	27	15	27	3	9	27	27	27
2012	27	25	27	11	19	27	27	27
2013	27	27	27	27	27	27	27	27

Table 1. The planned number of operational EVLA antennas offering wide-band tuning capability at the beginning of each year, for each band.

Phase II

The NSF held a “Reverse Site Visit” to review the Phase II proposal at NSF headquarters in June 2005, and we await the panel's report. The Phase II proposal is now available for public access at *http://www.aoc.nrao.edu/evla/library.shtml.*

R. Perley, P. Napier

Expanded Very Large Array (EVLA) Town Meeting

A Town Meeting will be held at the January 2006 meeting of the American Astronomical Society (AAS) to inform the AAS membership of the status of the EVLA Project. By the time of the Washington D.C. AAS meeting, the EVLA will have completed outfitting five antennas in the 27-telescope array, and installation will have begun of the new wide-band L (1-2 GHz) and C-band (4-8 GHz) receivers. The Canadian partners will have made considerable progress on the EVLA correlator. Brief presentations will be made at the Town Meeting regarding: (a) the exciting science opportunities enabled by the EVLA; (b) an overview of the project and construction progress; and (c) the correlator. At least half of the hour-long Town Meeting will be allocated for answering questions from the audience.

VLA Configuration Schedule; VLA/VLBA Proposals

Configuration	Starting Date	Ending Date	Proposal Deadline
C	08 Jul 2005	03 Oct 2005	1 Feb 2005
DnC	14 Oct 2005	31 Oct 2005	1 Jun 2005
D	04 Nov 2005	17 Jan 2006	1 Jun 2005
A(+PT?)	03 Feb 2006	15 May 2006	3 Oct 2005
BnA	26 May 2006	12 Jun 2006	1 Feb 2006
B	16 Jun 2006	18 Sep 2006	1 Feb 2006
CnB	29 Sep 2006	16 Oct 2006	1 Jun 2006
C	20 Oct 2006	16 Jan 2007	1 Jun 2006
DnC	26 Jan 2007	12 Feb 2007	2 Oct 2006
D	16 Feb 2007	14 May 2007	2 Oct 2006
A	01 Jun 2007	10 Sept 2007	1 Feb 2007

GENERAL: Please use the most recent proposal coversheets, which can be retrieved at *http://www.nrao.edu/administration/directors_office/tel-vla.shtml* for the VLA and at *http://www.nrao.edu/administration/directors_office/vlba-gvlbi.shtml* for the VLBA. Proposals in Adobe Postscript format may be sent to *propsoc@nrao.edu*. Please ensure that the Postscript files request U.S. standard letter paper. Proposals may also be sent by paper mail, as described at the web addresses given above. FAX submissions will not be accepted. Finally, VLA/VLBA referee reports are now distributed to proposers by email only, so please provide current email addresses for all proposal authors via the most recent LaTeX proposal coversheets.

VLA: 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 90cm (solar and other interference; disturbed ionosphere, especially at dawn), deep 20cm observations (solar interference), line observations at 18 and 21cm (solar interference), polarization measurements at L-band (uncertainty in ionospheric rotation measure), and observations at 2 cm and shorter wavelengths in B and A configurations (trophospheric phase variations, especially in summer). Proposers should defer such observations for a configuration cycle to avoid such problems. In 2006, the A configuration daytime will involve RAs between 21h and 04h. Current and past VLA schedules may be found at *http://www.vla.nrao.edu/astro/prop/schedules/old/*. EVLA construction will continue to impact VLA observers; please see the web page at *http://www.aoc.nrao.edu/evla/archive/transition/impact.html.*

Approximate VLA Configuration Schedule

	Q1	Q2	Q3	Q4
2005	A,B	B,C	C	D
2006	A	A,B	B,C	C
2007	D	D,A	A	A,B

VLBA: Time will be allocated for the VLBA on intervals approximately corresponding to the VLA configurations, 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. Any proposal requesting a non-VLBA antenna is ineligible for dynamic scheduling, and fixed date scheduling of the VLBA currently amounts to only about one quarter of observing time. Adverse weather increases the scheduling prospects for dynamics requesting frequencies below about 10 GHz. When the VLA-Pie Town link is in use during the VLA's A configuration, we will try to substitute a single VLA antenna for Pie Town in a concurrent VLBA dynamic program. Therefore, scheduling prospects will be enhanced for VLBA dynamic programs that can accommodate such a swap. See *http://www.vlba.nrao.edu/astro/schedules/* for a list of dynamic programs which are currently in the queue or were recently observed. VLBA proposals requesting the GBT, the VLA, and/or Arecibo need to be sent only to the NRAO. Note also the possibility to propose for the High Sensitivity Array (see *http://www.nrao.edu/HSA*). Any proposal requesting NRAO antennas and antennas from two or more institutions affiliated with the European VLBI Network (EVN) is a Global proposal, and must reach *both* the EVN scheduler and the NRAO on or before the proposal deadline. VLBA proposals requesting only one EVN antenna, or requesting unaffiliated antennas, are handled on a bilateral basis; the proposal should be sent both to the NRAO and to the operating institution of the other antenna requested. Coordination of observations with non-NRAO antennas, other than members of the EVN and the DSN, is the responsibility of the proposer.

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

Prompt ToO Overrides for Large VLA Proposal AK583

As announced in April 2005, we have begun a scheme wherein the team for the Large VLA Proposal AK583 is authorized to conduct prompt target-of-opportunity (ToO) overrides in response to certain Gamma Ray Bursts. About one such override per week is expected through the end of the move from the A to the BnA configuration in May 2006. Time taken from filler proposals for such overrides will not be rescheduled, as is the custom. Time taken from a few other proposals for such overrides will be rescheduled on a best-effort basis. To minimize the impact of overrides during segments longer than a few hours, we remind observers that it is always prudent to include more than one observation of a primary flux density calibrator.

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

VLBI Global Network Call for Proposals

Proposals for VLBI Global Network observing are handled by the NRAO. There are three Global Network sessions per year, with up to three weeks allowed per session. The Global Network sessions currently planned are:

Date	Proposals Due
20 Oct to 10 Nov 2005	01 Jun 2005
16 Feb to 09 Mar 2006	01 Oct 2005
01 Jun to 20 Jun 2006	01 Feb 2006
19 Oct to 09 Nov 2006	01 Jun 2006

Any proposal requesting NRAO antennas and antennas from two or more institutions affiliated with the European VLBI Network (EVN) is a Global proposal, and must reach *both* the EVN scheduler and the NRAO on or before the proposal deadline. FAX submissions of Global proposals will not be accepted. A few EVN-only observations may be processed by the Socorro correlator if they require features of the EVN correlator at JIVE which are not yet implemented. Other proposals (not in EVN sessions) that request the use of the Socorro correlator must be sent to NRAO, even if they do not request the use of NRAO antennas. Similarly, proposals that request the use of the EVN correlator at JIVE must be sent to the EVN, even if they do not request the use of any EVN antennas. All requests for use of the Bonn correlator must be sent to the MPIfR .

Please use the most recent proposal coversheet, which can be retrieved at *http://www.nrao.edu/administration/directors_office/vlba-gvlbi.shtml*. Proposals may be submitted electronically in Adobe Postscript format. For Global proposals, those to the EVN alone, or those requiring the Bonn correlator, send proposals to *proposevn@hp.mpifr-bonn.mpg.de*. For Global proposals that include requests for NRAO resources, send proposals to *propsoc@nrao.edu*. Please ensure that the Postscript files sent to the latter address request U.S. standard letter paper. Proposals may also be sent by paper mail, as described at the web address given. Only black-and-white reproductions of proposal figures will be forwarded to VLA/VLBA referees. Finally, VLA/VLBA referee reports are now distributed to proposers by email only, so please provide current email addresses for all proposal authors via the most recent LaTeX proposal coversheet.

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

Proposal Tool

As reported in the previous issue of the newsletter, the NRAO-wide proposal tool was inaugurated for the June 2005 GBT proposal deadline. For that deadline, 58 proposals were successfully submitted with the new tool. Feedback from users was mostly very positive, with some suggestions for improvement which will be used to guide modifications to the tool for the October 2005 GBT deadline.

The goal of the project is to create a NRAO-wide proposal submission tool, and though initially it has focused on GBT submission only, it has been designed from the start to allow adding support for other telescopes with relative ease. The next telescope for which we plan to use the new tool is the VLA. Though we had hoped to offer it to VLA proposers for the October 2005 deadline, it was decided to eliminate a few VLA-specific wrinkles first and release it for the February 2006 deadline instead. This will also allow more elaborate VLA specific testing by NRAO staff during the upcoming October 2005 deadline.

A second, equally important element of this effort is the NRAO user database, developed concurrently with the proposal tool. To use the proposal tool, one has to be registered in the new NRAO user database. For the upcoming deadline all GBT proposers have to be registered, as will all VLA proposers for the February 2006 deadline. Though the user database is currently integrated only with the proposal tool, we are in the process of integrating it with other NRAO applications requiring user authentication, such as access to the NRAO archive.

Even though the new proposal tool will not be used for the VLA until next year, prospective VLA proposers may want to register in the NRAO user database; though not required in the current round of VLA proposals, we encourage scientists to register early at *http://e2e.nrao.edu/userdb/*. An additional benefit of registration is that, once we have completed integration of the VLA archive and the user database some time later this year, it also will allow easier access to one's own proprietary data.

Gustaaf van Moorsel

The Second Anniversary of the NRAO Science Data Archive

The NRAO Data Archive has been operational since October 15, 2003. The archive system allows everyone on-line access to all VLA data and some VLBA and GBT data (*http://archive.nrao.edu/ archive*). To date, over 700 users from 250 institutions have downloaded over 4 Tbytes of telescope data (nearly 30,000 data files). The download data rate has climbed to about 200 Gbytes per month (1600 data files per month). Data files over one year old are in the public domain and account for over one-half of the download volume. The data files reside on a hard disk array and provide the archive users with fast access and downloads via ftp and http.

Currently, the archive contains all VLA data going back to 1976, raw VLBA data going back to September 1999 (with some gaps), and some calibrated VLBA data going back to October 1999. Efforts to expand the VLBA archive back to 1992, are underway and should be complete by the end of 2005. GBT data from July 2002 through October 2004 are available in the archive. During the fourth quarter of 2005, we will bring the archived GBT dataset up-to-date with the GBT dataset at Green Bank. By the end of the year 2005, we expect the archive to be over 25 TBytes in size.

An NRAO Virtual Observatory (VO) Plan has been written and near-term, mid-term and far-term goals have been identified. For the archive system in the near-term, we will identify and select processed data products to be included in the archive and made available through VO services. In the beginning, these data products will mostly consist of images from NRAO surveys and large proposed observing projects. During the second quarter of 2005, we have made some progress on our near-term VO goals. Currently, over 30,000 images from the NRAO VLA Sky Survey (NVSS), Faint Images of the Radio Sky at Twenty-Centimeters (FIRST), and 2cm VLBA surveys are loaded and cataloged in the archive. A VO Simple Image Access service has been constructed for the NRAO Image Archive and is under final testing. We expect the NRAO VO Simple Image Access service to be operational by October 2005.

Our goal is to greatly expand the archive collection of VLA, VLBA, and GBT images. To that end, we request that investigators holding or acting as curator of image surveys observed with NRAO telescopes make their surveys available to the NRAO Archive. The images will be published to the VO services and made directly available to users through NRAO Archive image query tools. To begin, we are primarily interested in surveys since they form collections whose observing parameters are more easily characterized. For more information, please contact *jbenson@nrao.edu*.

In the future, we will request users to submit individual images from scheduled, pointed observations. The individual pointed images will be archived with links to their raw and calibrated data, observing logs, proposals and other heuristical information. The design and construction of such a linkage will extend well into 2006.

Within the next year, the NRAO Science Data Archive will become more integrated into emerging e2e systems, primarily the Proposal Tool and User Database Tool. We also expect to begin acquiring and implementing the ALMA-ESO archive technology in the form of Next Generation Archive Systems (NGAS) hardware modules and especially the NGAS software technology. We hope to "break the ice" on NGAS by the end of 2005. VLA, VLBA, and GBT data acquired beginning in 2006 should be archived in NGAS modules at the Array Operations Center.

John Benson

St. Croix Antenna Maintenance

Figure 1. Patching a subreflector support leg on the VLBA antenna at St. Croix.

A lengthy maintenance visit was made to the VLBA antenna in St. Croix April 4 - 22, 2005. The main emphasis of the visit was corrosion control. Rust holes in a subreflector support leg were cleaned and patched (Figure 1). Walkway grating around the vertex room, a corroded support platform, the elevation cable wraps, and other corroded components on the antenna were replaced. Another major task performed during the maintenance visit was the overhaul of the antenna's focus rotation mount (FRM). The overhaul included the rebalancing of the antenna's subreflector to improve focus rotation (Figure 2), the repair of a broken segment on the rotation bearing, and the repair of FRM electrical problems, such as an oscillating rotation motor that was causing positioning errors. As part of a VLBA-wide servo upgrade project, the antenna's original analog tachometers were replaced with new digital tachometers, and an upgraded version of the antenna control unit backplane was installed. An azimuth drive motor and an elevation drive motor were also replaced. A water leak had developed in the feed cone of the antenna's vertex room. The feed cone was sealed and painted above and below the antenna's primary reflector. The water leak had damaged the floor tiles in the vertex room. The flooring was repaired, sealed, and painted.

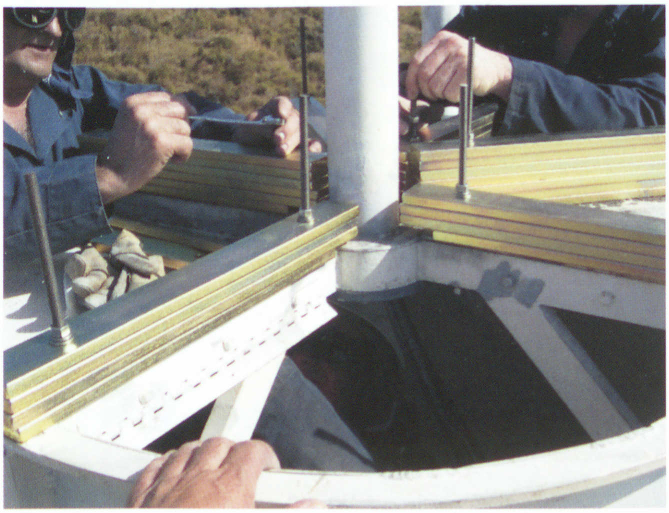


Figure 2. Installing counterweights to balance the St. Croix subreflector.

The cryogenics system on the antenna was overhauled July 28 - August 3, 2005. The cryogenic compressors were reconditioned by replacing their electrical wiring, high temperature protection, fan motors, and electrical contactors (Figures 3 and 4). The Aeroquip fittings on the cryogenic lines were replaced. A special plastic coating was developed for the new fittings to prevent corrosion. Charcoal traps were rebuilt and evacuated, and the vacuum pumps were serviced. The overhaul was completed with the evacuation, cooling, and testing of the complete cryogenics system and associated receivers.

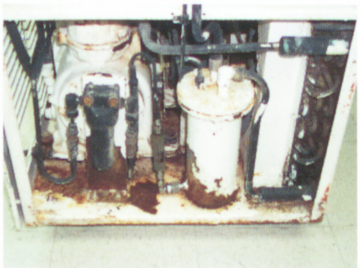


Figure 3. St. Croix cryogenic compressor before reconditioning.

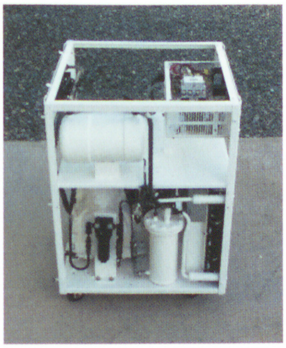


Figure 4. St. Croix cryogenic compressor after reconditioning.

M. McKinnon, E. Carlowe, J. Meadows, P. Rhodes

Tenth Synthesis Imaging Summer School

The Tenth Synthesis Imaging Summer School will be held June 13-20, 2006, at the University of New Mexico, Albuquerque, and at the Array Operations Center (AOC) of the NRAO in Socorro, New Mexico. The School will comprise lectures on the fundamentals of radio interferometry, including both connected element and very long baseline interferometers, and some advanced lectures on specialized topics. Data reduction tutorials at the AOC will provide hands-on experience with data calibration and imaging for VLA, VLBA, and mm/submm data. Attendance at the Summer School will be limited to 150 people. Further details about the School will be announced shortly, including information on how to register.

Claire J. Chandler, on behalf of the Local Organizing Committee

Green Bank

The Green Bank Telescope

Excellent progress continues to be made on a number of Green Bank Telescope (GBT) developments spanning a wide range of areas.

GBTIDL Version 1.1.1 was released on August 15. GBTIDL is an interactive package for reduction and analysis of spectral line data taken with the GBT. The package consists of a set of straightforward yet flexible calibration, averaging, and analysis procedures (the "GUIDE layer") modeled after the UniPOPS and CLASS data reduction philosophies, a customized plotter with many built-in visualization features, and Data I/O and toolbox functionality that can be used for more advanced tasks. The entire package is written in IDL. The package is available through SourceForge at: *http://gbtidl.sourceforge.net/*.

Version 1.1.1 is an update that includes new features and bug fixes. Courtesy of Glen Langston, GBTIDL now has the ability to export calibrated data to AIPS for further processing using the AIPS single-dish facilities. This provides a path to a powerful suite of imaging facilities.

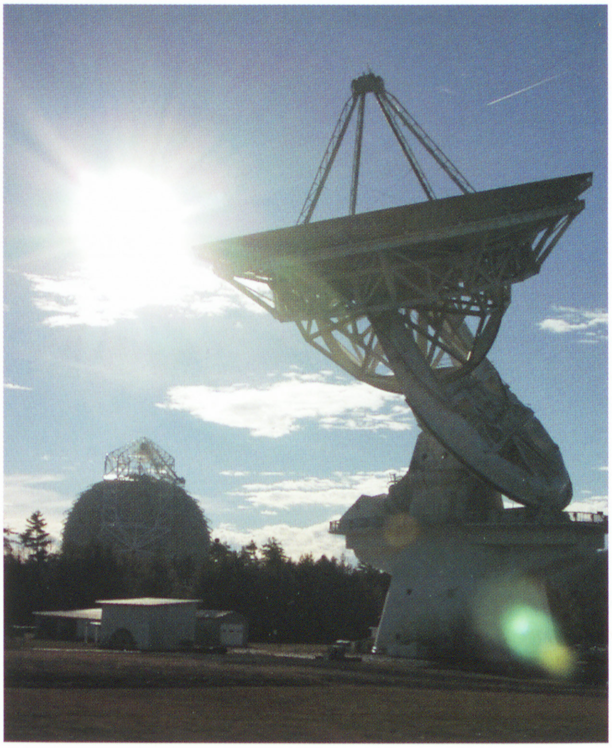
ASTRID, the Astronomer's Integrated Desktop, was released for use by visiting observers on July 1. ASTRID is a unified workspace that incorporates both the GBT's new Scheduling Block-based observing system and the real time quick look display, GFM (GBT Fits Monitor). ASTRID seamlessly combines both telescope configuration and antenna movement; this allows observers to build observing scripts in Python well in advance of their observations. Currently, ASTRID supports most types of GBT observations, with the exception of non-sidereal sources (e.g. solar system objects) and the data-taking control of the pulsar spigot. Both of these are currently being added with deliveries on track for October. More information on ASTRID can be found online at: *http://wiki.gb.nrao.edu/bin/view/Data/AstronomersIntegratedDesktop*.

Information on Scheduling Blocks and examples can be found at: *http://wiki.gb.nrao.edu/bin/view/Software/ObservingTools*.

Excellent progress continues to be made on instrumentation. The modifications to the Ka-band (26-40 GHz) receiver required to provide both polarizations are complete. The receiver will be re-commissioned this fall, and should be available for astronomical use by December. Work on the Caltech Continuum Backend is also proceeding according to schedule. The hardware is complete and software/firmware development is almost complete. The hardware has passed extensive functional testing in the lab, thus far, with flying colors.

The Penn Array receiver is also nearing its first use on the GBT. A number of significant milestones have been achieved recently. Chief among them was receipt of the full complement of SQUID multiplexers at NASA GSFC. Prototype bolometer arrays with lightly passivated bismuth absorber have already been produced, and with receipt of the SQUID MUXes, production of a full-scale, functional bolometer array is proceeding. In August the receiver and its full suite of supporting electronics was successfully installed on the GBT to check physical, electronic, and software interfaces. It also passed a week of rigorous RFI tests in the anechoic chamber which ensure that the Penn Array will not interfere with other, lower-frequency Green Bank experiments. Software was completed that interfaces the Penn Array with the GBT YGOR control system, and an alpha version of a FITS data archiver was produced. We plan to commence engineering tests of the receiver on the in February 2006.

Richard Prestage



The 43m telescope moving during tests of refurbishment of hydraulic systems. The GBT is in the background.

Bi-Static Radar Collaboration to Measure the Earth's Ionospheric Turbulence

Lincoln Laboratories and the NRAO are collaborating to measure the properties of the Earth's ionosphere using bi-static radar techniques. Lincoln Laboratories is building a special wide-band (150 to 1700 MHz) feed and front end system that will be installed on the NRAO 43m (140ft) telescope. The NRAO is developing an automated system to follow Lincoln Laboratory's spacecraft coordinates. The 43m will track spacecraft beacons and also spacecraft illuminated by the Millstone Radar at Haystack, Massachusetts.

Lincoln Laboratory's engineers will drive a semi-trailer full of high-speed electronics to Green Bank, where it will be installed at the base of the 43m telescope. The trailer is shielded to contain any radio frequency interference the electronics may generate. The Lincoln Laboratory's electronics will select and sample the RF signals and write the digital data to a disk recording system. The disk packs will be mailed to the Lincoln Laboratories office in Lexington, Massachusetts for further analysis.

The 43m operations was shut down in 1999, and the NRAO feared that it might not be possible to fully restore the 43m to operations. Detailed tests of the hydraulics system were required before the collaboration could begin. The Green Bank staff have worked with dedication to restart the 43m system. The 43m hydraulic systems have now been restored to full operations, and a new control computer system has been installed. We greatly appreciate the hard work of all those who have contributed to this success.

We expect to install the Lincoln Laboratories feed and front end system in September 2005 and make the first test observations in October 2005.

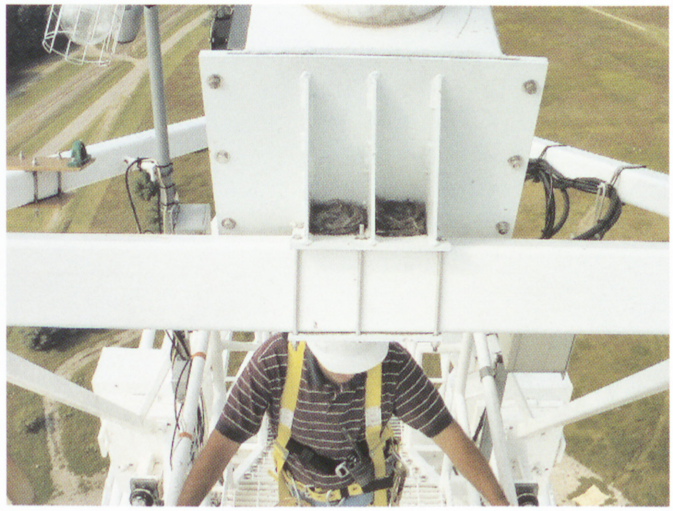
Lincoln Laboratories is operated by the Massachusetts Institute of Technology for the United States Air Force.

G. Langston, R. Prestage, P. Jewell

The View from the Top

A number of Green Bank employees from the Telescope Operations and Electronics Divisions travel to the top of the Green Bank Telescope for maintenance and modification activities. While the view is magnificent, it is not for the faint of heart! These photos were taken by Maintenance Supervisor Harry Morton.

Telescope Mechanics Edgar Friel, Shaun Nottingham, Phillip Rittenhouse, and Electronics Engineer Bob Simon, and Technician Bill Bennett recently removed a Holography receiver from the telescope. The old 85-3 telescope and the Interferometer Control Building are visible below.



Industrious birds built these nests on top of the GBT. While this photo shows them sitting vertically, this perch tips nearly horizontal during observing! Operations Division Head Bob Anderson is visible just below the nests.

Telescope Mechanic Edgar Friel sits astride a beam to lower the receiver.

A summer painter works from a manlift over 100 feet from the ground to reach the bottom of the feed arm of the GBT (red arrow indicates the lift).

Education and Public Outreach

Governor's School at the Observatory

On July 30, 2005, NRAO staff embarked on a new educational experiment as 56 bright 14 year-olds descended on the Observatory for a two-week camp experience. The West Virginia Governor's School for Math and Science was, for the first time last year, open to competition via a grant proposal process. The NRAO and the National Youth Science Foundation (parent organization of the National Youth Science Camp which has been held in Bartow, WV since 1963) joined forces to vie for funds to hold a Governor's School at the Observatory, and won.

It seemed like a grand idea in January, but as July rolled around, the staff, including me, were decidedly nervous. We wondered and worried about whether our teacher institute program could be translated into a viable program for students. And the sheer numbers were daunting: 56 adolescents on site for two weeks!

Fortunately, we had engaged the services of 11 science-oriented college students, and 11 science teachers—all veteran teacher institute graduates—to assist us. The teacher-pupil ratio was excellent, and this fact kept panic at bay as the students and their families began to arrive that Sunday.

The West Virginia Governor's School for Math and Science (GSMS) is funded by the West Virginia Experimental Program to Stimulate Competitive Research (EPSCoR). Their aim is to provide enrichment opportunities in science, technology, engineering, and mathematics early in the educational "pipeline", before students make academic and career related decisions.

Our program was a unique and synergistic mix of National Youth Science Camp style activities and the research institute program that NRAO has been offering to teachers since 1987. Our goal was to help promising middle school students understand the processes involved in scientific research. Students were organized into 11 small research teams and given

observing projects on the 40 Foot Telescope early during the school. These projects formed the nucleus around which most other educational activities were built.

Most days were organized into four activity blocks. After breakfast the entire group met in the Jansky Lab auditorium for a short session called "Foundations", where NRAO staff introduced astronomy and radio astronomy concepts to the students. "Directed Studies" followed. Modeled after National Youth Science Camp, directed studies provide students an opportunity to delve more deeply into a topic. Our sessions included "Astronomical Image Processing", where students learned how to analyze FITS data files, and "Electronics", where students experimented with circuits and soldered electronic kits. The third block, "Natural Sciences", took advantage of the NRAO site: students collected data and analyzed the quality of a one-mile stretch of Deer Creek. Our directed study blocks spanned six hours over two days. All directed study sessions were held concurrently; students rotated through each topic so that by the end of the school all had participated. Our teacher-staff organized and led these sessions.

After lunch, recreational activities were organized, and led by our college student mentors. GSMS students signed up for activities that included fossil-hunting, mountain biking, ballroom dancing lessons, ultimate frisbee, berry picking, and caving.

In the evenings, the whole group reconvened for "Research Talks". Here, students learned about cutting-edge research from the scientists conducting that research. These talks were of great interest to students as they were often topically related to their own research problems.

One aspect of the National Youth Science Camp program was essential to the success of the Governor's school, and that is their philosophy of "Carpe Diem". We did not provide our students with a two week agenda of classes and activities. Instead, each morning a general itinerary was posted. This allowed the staff to make frequent modifications to the schedule, and still appear to be organized! It also allowed us to surprise the students, and we did. Jay Lockman organized an old-time band and we held a square dance one evening in the shadow of the 45 Foot Telescope. They joined in the NRAO company picnic, and took a chartered steam locomotive to a graduation celebration.

The most exciting of all surprises was our foreknowledge that the students would receive observing time on the Robert C. Byrd Green Bank Telescope. Saturday morning, mid-way through the school, Ron Maddalena summoned the group to announce the good news. Each of the eleven research teams would have one hour of telescope time. It was absolutely thrilling to hear the gasps and murmurs following the announcement.

The students were given a list of possible (and not possible) objects to observe and some choices with regard to receivers and backends. The students were told to devise a question to answer with the GBT that was related to their 40 Foot research and submit their abstract to Ron Maddalena for evaluation. Team abstracts were promptly delivered, some quite imaginative, and some not above a bit of flattery. Eventually all abstracts were approved and, over three nights, student teams, with the help of Maddalena, collected data with the GBT.

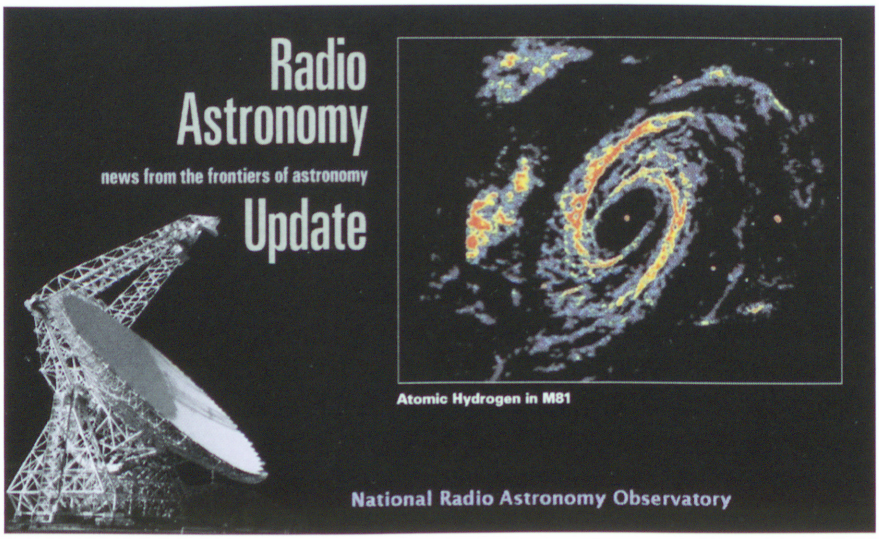
As do all good scientists, Governor's School students presented the results of their research on the final full day of the camp. All-in-all, we were very impressed by the students' data analysis abilities, and their adherence to evidence as they presented their work. They were serious and unafraid as they submitted their observing techniques, results, and interpretations for critique by others.

On the final day, anxious parents arrived early for a glimpse of their children. Instead they were directed to the science center to view posters describing the students' work. Parents and students soon came together for a brief graduation ceremony and picnic lunch. Students were reluctant to leave. We were reluctant to let them go. Because, with just a moment to stop and reflect on the previous two weeks, it was obvious from an educational point of view that this had been an extraordinary experience for everyone. These bright young people, just prior to entering high school, experienced science and math. They were so game. I can't say exactly how the Governor's School will influence these students' academic and career decisions in high-school and beyond, but I know it will.

The Governor's School for Math and Science was possible and successful because of the positive attitudes and volunteerism of the NRAO staff: Richard Prestage, Ron Maddalena, Karen O'Neil, Frank Ghigo, Larry Morgan, Jay Lockman, Glen Langston, Toney Minter, Paul Marganian, Carl Bignell, Rich Lacasse, Wes Sizemore, Mike Stennes, Dennis Egan, John Ford, Rachel Osten, Mark Adams, Becky Warner and the cafeteria staff, the Plant Maintenance group, and all of the wonderful folks at the Science Center who took care of us every day. Thanks also to Farhad Yusef-Zadeh, who was visiting from Northwestern University.

Sue Ann Heatherly

Science Museum Outreach



The next time you visit a science museum or planetarium, you may catch a glimpse of recent NRAO news on ViewSpace, a multimedia exhibit developed by the Hubble Space Telescope's Informal Science Education team. ViewSpace delivers a series of visually stunning modules with associated text and space music to more than 70 participating institutions world wide. These modules convey information on a variety of astronomical topics with an emphasis on recent findings and basic concepts. The program is distributed to participating institutions via the Internet, allowing information to be disseminated the moment it is released.

The current NRAO offering, called Radio Astronomy Update, showcases NRAO science releases that have associated high-resolution imagery. Future offerings will include an overview of radio astronomy, as well as programs that highlight NRAO telescopes and their science.

You can learn more about ViewSpace by visiting the following URL: *http://hubblesource.stsci.edu/exhibits/viewspace/.*

Andrea Gianopoulos

In General

2005 NRAO Summer Student Research Programs

Figure 1. Charlottesville Summer Students (l-r): Amanda Heiderman, Julia Sandell, Ben Sulman, Kelly Freed, Leye Olorode, Cate Grier, Mike McCarty. Not shown: Vinayak Nagpal.

Figure 3. Socorro Summer Students (l-r), front: Nicole Gugliucci, Tyson Mao. Back: JoAnna Johnston, Wendy Bennett, Kassandra Wells, Kasandra Jorgensen, Emily Levesque, Kyle Borg, Ricardo Sánchez.

August brought to a close the 46th year of the NRAO Summer Student program. The 2005 class consisted of 29 students: 18 undergraduate students supported by the National Science Foundations "Research Experience for Undergraduates" (REU) program; and eleven graduating seniors or graduate students supported by the NRAO Graduate or Undergraduate Summer Student program. Eleven students traveled to Socorro, nine to Charlottesville, and nine to Green Bank (see accompanying figures). These 29 students were chosen from 126 applications.

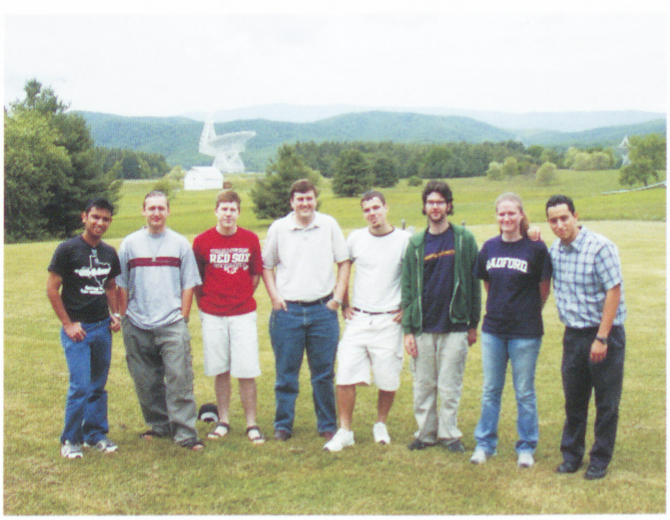


Figure 2. Green Bank Summer Students (l-r): Soumya Gosh, James Durand, Peter Williams, John Brewer, Conor Mancone, Jason Curtis, Robin Pulliam, David Sevilla.

The students spent 10-12 weeks this past summer working with an NRAO mentor on a project in the mentor's area of expertise. At each site students attended a summer lecture series, participated in informal lunch discussions with staff on various aspects of careers in astronomy, and went on field trips to other observatories. Students also conducted their own observing projects, with Socorro students observing with the VLA and VLBA, and Green Bank and Charlottesville students observing with the GBT.

The accompanying table lists the names and home institutions of all 2005 summer students, together with their NRAO mentor, site, and project title. More detailed descriptions of the student projects are available at *http://www.nrao.edu/students/archive/projects.php*. Applications for next year's Summer Student program will be accepted starting in October 2005. Details on these and all NRAO student programs are available at *http://www.nrao.edu/students/*.

John Hibbard

2005 NRAO Summer Students/Mentors

Student	School	Project	Mentors	Site	Program
Oluleye Olorode	Benedict College	*Development and Evaluation of a 1.5-THz Heterodyne Test Receiver*	Eric Bryerton	CV	NRAO uGRP
Conor Mancone	University of Florida	*200-240 GHz Spectral Line Survey of IRC+10216*	Phil Jewell	GB	NSF REU
Robin Pulliam	Radford University	*The Filling Factor of Electrons in the Warm Ionized Medium*	Anthony Minter	GB	NSF REU
James Durand	NMSU	*A Supervisory Control and Data Acquisition (SCADA) system for the 140ft telescope*	John Ford	GB	NSF REU
Kassandra Wells	Carleton College	*Observations of the Sunyaev-Zeldovich Effect with the CBI*	Steve Myers	Soc	NSF REU
Julia Sandell	Barnard College/ Colmubia University	*HI and GALEX Observations of Interacting Galaxies*	John Hibbard	CV	NSF REU
Kelly Freed	Metropolitan State College of Denver	*The Star Formation Environment of the IRAM04191 Protostar*	Jeff Mangum	CV	NSF REU
Catherine Grier	University of Illinois	*Statistical Study of H_2O Megamaser Systems*	Jim Braatz	CV	NSF REU
Amanda Heiderman	Univ California - Berkeley	*A VLA HI and Spitzer mid-IR Study of Hickson Compact Group 7*	John Hibbard (NRAO) & Kelsey Johnson (UVa)	CV	NRAO GRP
Kasandra Jorgensen	Lewis & Clark College	*The Physical Structure of the Incipient Stages of Low-mass Star Formation*	Yancy Shirley	Soc	NSF REU
Kyle Borg	Austin College	*CCS Emission from Infrared Dark Clouds*	Claire Chandler	Soc	NSF REU
Michael McCarty	Morehead State University	*GBT Pulsar Observations*	Scott Ransom	CV	NSF REU
Tyson Mao	California Institute of Technology	*Radar mapping of Mars at Opposition*	Bryan Butler	Soc	NSF REU
Valeria Buenrostro-Leiter	Instituto de Astrofísica de Canarias (IAC)	*GBT HI Observations of High Velocity Clouds*	Jay Lockman	GB	NRAO GRP
Nicole Gugliucci	Lycoming College	*Exotic AGN from VLBI Surveys*	Greg Taylor	Soc	NRAO GRP
Emily Levesque	Massachusetts Institute of Technology	*Search for Interstellar OD*	Vincent Fish	Soc	NSF REU
Wendy Bennett	Drake University	*Fine Scale Structure in the Interstellar Medium*	J. P. Marcquart	Soc	NSF REU
Ricardo Sánchez	Rutgers The State University of NJ	*Gas Flows in the Barred Galaxy NGC 1365*	Gustaaf van Moorsel	Soc	NRAO GRP
Vinayak Nagpal	Chalmers University of Technology	*Development of an Adaptive RFI Mitigation System for the GBT*	Rich Bradley	CV	NRAO GRP
David Sevilla	The University of Texas at El Paso	*A Test Spectrometer for the Green Bank Electronics Division*	Rich Lacasse and John Ford	GB	NRAO GRP
Peter Williams	Harvard College	*New Generation Phase Calibrator*	Steven White	GB	NSF REU

2005 NRAO Summer Students/Mentors (continued)

Student	School	Project	Mentors	Site	Program
Benjamin Sulman	Oberlin College	*GBT Pulsar Observations*	Scott Ransom	CV	NSF REU
John Brewer	West Virginia University	*GBT 68-92 GHz Receiver Development*	Michael Stennes	GB	NSF REU
Soumya Ghosh	University of Houston	*Frequency of Execution Metrics for the GBT*	Nicole Radziwill	GB	NRAO GRP
Jason Curtis	UC Berkeley	*GBT OBservations of Ammonia (NH3) Towards The Galactic Center*	Glen Langston	GB	NSF REU
JoAnna Johnston	New Mexico Tech	*Mapping Water Vapor in the Atmosphere of Mars with the VLA*	Bryan Butler	Soc	NSF REU
John Kelly	University of Virginia	*Radio Observations of the Chandra Deep Field South*	Ken Kellermann	CV	NRAO GRP
Lawrence Weintraub	California Institute of Technology	*Multi-Epoch VLBA Polarimetry of the Gamma-Ray Blazar 2255-282*	Greg Taylor	Soc	NRAO GRP

Opportunities for Undergraduate Students, Graduating Seniors, and Graduate Students

Applications are now being accepted for the 2006 NRAO Summer Student Research Assistantships. Summer students conduct research under the supervision of an NRAO staff member at one of the NRAO sites on projects which may involve any aspect of astronomy, including original research, instrumentation, telescope design, or astronomical software development. Examples of past summer student research projects are available on the Summer Student website at *http://www.nrao.edu/students/NRAOstudents_summer.shtml.*

Summer students are chosen by each individual supervisor from all applications received, and the student will usually be located at the same NRAO site as the supervisor. Students are encouraged to review the webpages of NRAO staff for an idea of the types of research being conducted at the NRAO. On their application, students may request to work with a specific staff member or to work on a specific scientific topic, or to work at a specific site.

The program runs 10-12 weeks from early June through early August. At the end of the summer, participants present their research results in a student seminar and submit a written report. The summer projects often result in publications in scientific journals. Financial support is available for students to present their summer research at a meeting of the American Astronomical Society, generally at the winter meeting following their appointment.

Besides their research, students take part in other activities, including a number of social events and excursions, as well as an extensive summer lecture series which covers aspects of radio astronomy and astronomical research. Students also collaborate on their own observational projects using the VLA, VLBA, and/or GBT.

There are three types of Summer Student position available at the NRAO:

The ***NRAO Research Experiences for Undergraduates (REU)*** program is for undergraduates who are citizens or permanent residents of the United States or its possessions. This is funded by the National Science Foundation (NSF)'s Research Experiences for Undergraduates (REU) program.

The ***NRAO Undergraduate Summer Student Research Assistantship*** program is for undergraduate students or graduating seniors who are citizens or permanent residents of the United States or its possessions or who are eligible for a Curriculum Practical Training (CPT) from an accredited U.S. Undergraduate Program. This program primarily supports students or research projects which do not meet the REU guidelines, such as graduating seniors, some foreign undergraduate students, or projects involving pure engineering or computer programming.

The ***NRAO Graduate Summer Student Research Assistantship*** program is for first or second year graduate students who are citizens or permanent residents of the United States or its possessions or who are eligible for a Curriculum Practical Training (CPT) from an accredited U.S. Graduate Program.

The stipends for the 2006 Summer Student Program are $475 per week for undergraduates, and $510 per week for graduating seniors and graduate students. Students who are interested in Astronomy and have a background in Astronomy, Physics, Engineering, Computer Science, and/or Math are preferred. The same application form and application process is used for all three programs, and may be accessed at *http://www.nrao.edu/students/summer-students.shtml*. Required application materials include an on-line application form (including a statement of interest), official transcripts, and three letters of recommendation. The deadline for receipt of application materials is **Monday, January 23, 2006**.

F.J. Lockman
NRAO Summer Student Coordinator

GBT Student Support Program: Announcement of Awards

Four awards were made in April 2005 as part of the GBT Student Support Program. This program is designed to support GBT research by graduate or undergraduate students at U.S. universities or colleges, thereby strengthening the proactive role of the Observatory in training new generations of telescope users.

The April 2005 awards were in conjunction with approved observing proposals submitted at the February or an earlier deadline. Awards were made for the following students:

- Rik Williams (Ohio State University) in the amount of $1,500 for the proposal entitled *Searching for 21 cm Emission from Nearby X-ray Absorbers.*
- Esteban Araya (New Mexico Tech) in the amount of $35,000 for the proposal entitled *Continuing the GBT Search for H2CO 6cm Emission.*
- Dain Kavars (University of Minnesota) in the amount of $35,000 for the proposal entitled *OH Observations of HI Self-Absorption Clouds.*
- Paul Kondratko (Harvard University) in the amount of $28,400 for the proposal entitled *Monitoring of Five NGC4258-like Water Megamasers Discovered with the GBT and the DSN.*

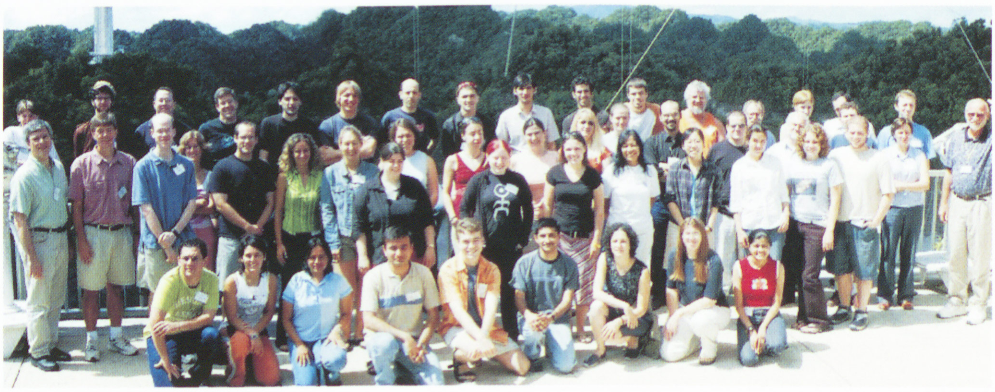
An additional five GBT Student Support Program awards were made in August 2005. The August awards were in conjunction with approved observing proposals submitted at the June deadline. Awards were made for the following students:

- M. Agueros (University of Washington) in the amount of $3,500 for the proposal entitled *Detecting Pulsar Companions to Two Very Low-Mass White Dwarfs.*
- S. Borthakur (University of Massachusetts) in the amount of $27,000 for the proposal entitled *What Happens to the Stripped HI in Compact Groups?*
- L. Hainline (Caltech) in the amount of $31,000 for the proposal entitled *A Survey of CO(1-0) from Dusty Submillimeter Galaxies with Known Redshifts.*
- A. Kepley (University of Wisconsin) in the amount of $3,000 for the proposal entitled *Magnetic Fields in Dwarf Irregular Galaxies: NGC 4214.*
- T. Robishaw (UC-Berkeley) in the amount of $27,900 for the proposal entitled *The Galactic Arachnid in the Ursa Major Loop.*

New applications to the program may be submitted along with new GBT observing proposals at any proposal deadline. For full details on this program and a cumulative record of past awards, select *GBT Student Support Program* from the GBT astronomers page at *http://wiki.gb.nrao.edu/bin/view/Observing/GbtStudentSupportProgram.*

K.E. Johnson (U Virginia), D.J. Nice (Princeton U), J.E. Hibbard, P.R. Jewell, F.J. Lockman, J.M. Wrobel (NRAO)

2005 NRAO/NAIC School on Single-Dish Radio Astronomy Techniques and Applications



The third in a series of NRAO/NAIC schools on the technical aspects of single-dish radio astronomy took place at Arecibo from July 10-16, 2005. Including lecturers, over 80 people took part in the school, representing approximately 16 different countries. The participants ranged from students to university faculty. The lectures for the school were given by the NRAO and the NAIC staff members as well as outside specialists. Topics covered all aspects of single-dish radio astronomy, from what can be seen in the radio sky, receiver and antenna design, how to write a good observing proposal, and what to look for in the future of radio astronomy. The banquet talk was given by Scott Ransom (NRAO-CV) on the most recent news and science from the pulsar community.

In addition to the lectures, each school participant had the opportunity to observe using either the Arecibo 305m or the GBT, and half a day was devoted to teaching the students about the Arecibo and Green Bank data reduction systems. A full day was devoted to reducing the data from the various observations and each observing group had the chance to present their results on Friday afternoon. On the Saturday following the school, approximately 40 of the participants went into Viejo San Juan to explore the forts and museums.

The school was a resounding success and our thanks go out to all the Arecibo staff who worked hard to keep it running smoothly. Additionally, we would like to thank the many lecturers who took time out of their schedules to come and help train what will hopefully be the next generation of Arecibo and GBT users.

Karen O'Neil

Rashid A. Sunyaev Selected for the 2005 Jansky Lectureship

Associated Universities, Inc., and the National Radio Astronomy Observatory are pleased to announce that the 40th annual Karl G. Jansky Lecture will be given by Rashid A. Sunyaev. Professor Sunyaev is Director of the Max Planck Institute for Astrophysics in Garching, Germany. He also remains Chief Scientist of the Space Research Institute of the Russian Academy of Sciences, is a member of the Russian Academy of Sciences, and a Foreign Associate of the National Academy of Sciences and the American Academy of Arts and Sciences.

Professor Sunyaev was educated at the Moscow Institute of Physics and Technology and received scientific degrees from Moscow University. He soon became one of the most important and prolific members of the Moscow group that pioneered many branches of Relativistic Astrophysics and Cosmology.

Rashid A. Sunyaev

Sunyaev was a student and long-term close collaborator of Yakov Zel'dovich. They studied important processes in the early universe, including the recombination of hydrogen and the formation of the cosmic microwave background (CMB) radiation spectrum. They predicted the recently discovered acoustic peaks in the CMB power spectrum and baryonic wiggles in the distribution of galaxies. At the same time, they predicted the decrement in the CMB due to the scattering of the CMB radiation from distant galaxy clusters (the S-Z effect).

Sunyaev's highly-cited paper with Nick Shakura introduced the standard theory of disk accretion onto black holes. Sunyaev also led the team that built and operated the KVANT X-ray Observatory attached to the MIR space station and the GRANAT orbiting X-ray observatory. KVANT made the first detection of X-rays from a supernova. Sunyaev leads the Russian participation in the ESA INTEGRAL hard X-ray and Gamma-Ray mission, and he is Co-Investigator of an experiment on the PLANCK Surveyor project.

Sunyaev's Jansky Lecture is titled "Cosmic Microwave Background Radiation, Clusters of Galaxies and Cosmology" and will be given in Charlottesville, Virginia on Sunday, October 23 at 5 p.m. in Gilmer Hall at the University of Virginia. Sunyaev will also deliver the Jansky Lecture on Monday, October 24 at 7:30 p.m. in the Science Center auditorium at Green Bank, West Virginia. A date and time have not yet been confirmed for Socorro, New Mexico. Updated information will be available at *www.nrao.edu/jansky*.

Mark Adams

NRAO Archives: Doc Ewen

The NRAO Archives is pleased to announce the availability of a web resource titled "Doc Ewen: The Horn, HI, and Other Events in U.S. Radio Astronomy", *http://www.nrao.edu/archives/Ewen/ewen.shtml*. Written by H.I. (Doc) Ewen, and illustrated with many photos and diagrams from Doc's collection, the pages describe the detection of the HI line in 1951, early U.S. radio astronomy history, including the building of the Harvard 24- and 60-foot antennas and the founding of NRAO, developments in millimeter and radiometric instrumentation in the 1970s through the 1990s, and Doc Ewen's continuing work in radiometry.

Working with E.M. Purcell at Harvard in 1951, Ewen detected radiation from galactic hydrogen at 1420 MHz. From 1952-1958 he was Co-Director of the Harvard Radio Astronomy Program, and during that time was a member of the committees that recommended the establishment of a national radio astronomy facility and Green Bank, West Virginia as the best site for what became NRAO. Between 1952 and 1958 he was CEO of both the Ewen Knight and Ewen Dae Corporations, was Executive VP of Millitech Corporation from 1989-1992, VP Special Projects at Millitech from 1993-2000, President of EK Associates 1992 to present, and Technical Operations Director of Special Projects LLC 2004 to present.

The NRAO Archives has been established to seek out, collect, organize, and preserve institutional records and personal papers of enduring value which document NRAO's historical development, institutional history, instrument construction, and ongoing activities. As the national facility for radio astronomy, the NRAO archives will also include materials on the history and development of radio astronomy in the U.S., particularly if such materials are in danger of being lost or discarded by other institutions or individuals.

For further information, please contact NRAO Archivist Ellen Bouton, *ebouton@nrao.edu*.

E.N. Bouton

Further Information

To obtain more information on the NRAO, visit the NRAO home page at: *http://www.nrao.edu*

To Contact any NRAO Site

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
(505) 835-7000

Tucson Site
ALMA Tucson
Electronics Division
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*
NRAO Preprints: *http://www.nrao.edu/library/listings/nrao_current.shtml*
Current VLA Observation Highlights: *http://www.vla.nrao.edu/genpub/current_obs/*

NRAO Products

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/*
The NRAO Data Archive System can be accessed and queried via the web: *http://e2e.nrao.edu/archive/*
Green Bank Solar Radio Burst Spectrometer (SRBS): *http://www.nrao.edu/astrores/gbsrbs/*

Observing Information

VLA: *http://www.vla.nrao.edu/astro*
VLBA: *http://www.aoc.nrao.edu/vlba/html/vlbahome/observer.html*
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 Public Information Officers: Dave Finley (*dfinley@nrao.edu*) or
Andrea Gianopoulos (*agianopo@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 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