NRAO Newsletter

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

April 2002 www.nrao.edu/news/newsletters Number 91

DIRECTOR'S OFFICE

NRAO Budget Request For 2003

The 2003 budget request for the National Science Foundation, sent to Congress by the President, contained a cut of about 3 percent for the physical sciences, including such disciplines as physics, chemistry, and astronomy. As part of this general trend, the request for NRAO operations was approximately $800,000 below the funding level for 2002. At this request level the Observatory would face significant problems in conducting its programs. In contrast to this discouraging news, the request for ALMA (see article page 2) was $30 million for the second year of construction, a substantial increase over 2002.

There are some indications that Congress might increase the funding for NSF above the request level, as was done in 2002. Meanwhile, NRAO has taken the prudent step of freezing some open positions while assessing the impact of the requested budget for 2003.

P. A. Vanden Bout

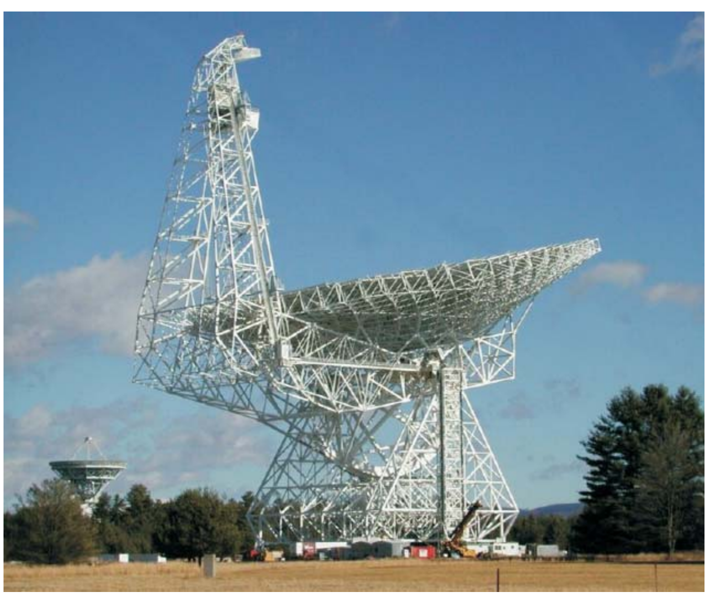
Visiting and Users Committees to Meet

The NRAO Visiting Committee is scheduled to meet April 4-5 at the Array Operations Center in Socorro, NM. The members of the Visiting Committee are: Geoffrey Blake, Roger Brissenden, Philip Diamond, Jacqueline van Gorkom, Lincoln Greenhill, Karl Menten, Joseph Miller, Ralph Pudritz, Philip Schwartz, Stuart Vogel (Chair), Sander Weinreb, and Eric Wilcots.

The NRAO Users Committee is scheduled to meet May 20-21 in Green Bank, WV. The members of this Committee are Rachel Akeson, David Boboltz, Steven Charnley, Christopher De Pree (Chair), John Dickey, Sean Dougherty, Jason Glenn, Mark Gurwell, Deborah Haarsma, Andrew Harris, Deidre Hunter, Victoria Kaspi, Joseph Lazio, Colin Lonsdale, Kevin Marvel, Stephen Thorsett, Thomas Troland, Liese van Zee, Eric Wilcots, Min Yun, and Farhad Yusef-Zadeh.

Users of NRAO facilities and other interested parties are invited to communicate their concerns to these committees, either through a member or the chairperson.

P. A. Vanden Bout



The Green Bank Telescope photo was featured as the "Astronomy Picture of the Day" on March 11, 2002.

Index

ALMA

President Bush released his FY2003 budget request to Congress on February 4, 2002. Here is a quote from the text of that request:

> "Just as Olympic athletes need the finest equipment and training protocols to triumph, so do scientists, engineers, and their students need the most modern research instruments with the best capabilities, the farthest reach, and the finest accuracy. The budget allocates $30 million for the next phase of construction of the Atacama Large Millimeter Array (ALMA)—the world's most sensitive, highest resolution radio telescope used to study stellar evolution, galaxy formation, and the evolution of the universe itself."

This statement needs little embellishment from me. Funding of $30M for 2003 for ALMA is consistent with our planned spending profile. Subject to approval by Congress, and action by the National Science Board, these funds could be available as early as October 2002. They will allow NRAO to begin construction of the ALMA infrastructure and to accelerate our fabrication of the array instrumentation. The scope of the construction project remains unchanged since it was baselined in April 2000.

Rapid progress is being made preparing for the delivery and testing of the first ALMA prototype antenna. VertexRSI is nearing completion of fabrication and factory integration of the major antenna components. These will be shipped to the VLA site where they will be erected this spring on an already completed foundation. Extensive tests are planned over the succeeding months to verify that the prototype meets all of the ALMA requirements.

Holographic and radiometric measurements of antenna performance will utilize hardware and software developed specifically for these tests by ALMA personnel in Tucson, Socorro, and Charlottesville. The testing program has been planned and will be carried out by an international team.

A second prototype antenna, provided by our European colleagues, is scheduled for delivery approximately a year later. Following an identical period of testing to verify its performance, the pair of antennas will be available for interferometric testing of ALMA prototype components and software.

M. D. Rafal

Completed foundation at the VLA site where the VertexRSI antenna components will be erected this spring. Extensive tests are planned to verify that the prototype will meet all of ALMA's requirements.

GREEN BANK

The Green Bank Telescope

Commissioning work and Early Science observations continue on the Green Bank Telescope. Our emphasis over the autumn and winter months has been to establish spectral line observing capability, to investigate low-frequency observing requirements, and to move to higher frequency operation. We continue to intersperse projects from the Early Science observing queue as soon as the required capabilities are available. Several of these programs have produced very significant, new results.

Last autumn, we began a concerted program to develop and release basic spectral line observing modes, beginning first with the requirements for 21 cm HI observations. This involved testing the GBT Spectrometer and the Spectral Processor in their high resolution modes, establishing fundamental observing modes, checking local oscillator control and Doppler tracking, and implementing various other infrastructure elements. This program has been successful, and culminated in January with the first spectral line observing program by John Dickey and Jay Lockman. We are still in the early stages of spectral line observing on the GBT, and several items that require follow-up work were found during the course of the development program and the first observing program. We will continue to expand and improve capabilities in the coming months.

We have also been investigating requirements and developing observing capabilities for the low frequency ranges, between ~300 and ~900 MHz. Radio frequency interference (RFI) is the major concern in these frequency bands. To help address these concerns, two additional engineers joined the GBT staff in January to work on RFI, electromagnetic compatibility, and spectrum management issues. They, together with existing staff members, have been characterizing RFI in these bands, from both off-site and on-site sources. A significant effort is in progress to identify and suppress local sources of RFI.

The primary commissioning initiative underway at present is to extend GBT observing capabilities through 26.5 GHz (K-band). Efficient observations at K-band require that we improve the surface accuracy of the dish through holography maps and subsequent corrections using the active surface; that we enable the active surface with an elevation-dependent look-up table of positions based on the finite element model of the structure and possible holography calibrations; that the subreflector be accurately positioned for optimal focus and gain; that wide bandwidth modes of the spectrometer be available; and that control and configuration software, and beam-switched observing modes be developed. The staff is currently conducting an intensive campaign to implement and test these capabilities, with a goal of having the first K-band observing program on the air this spring.

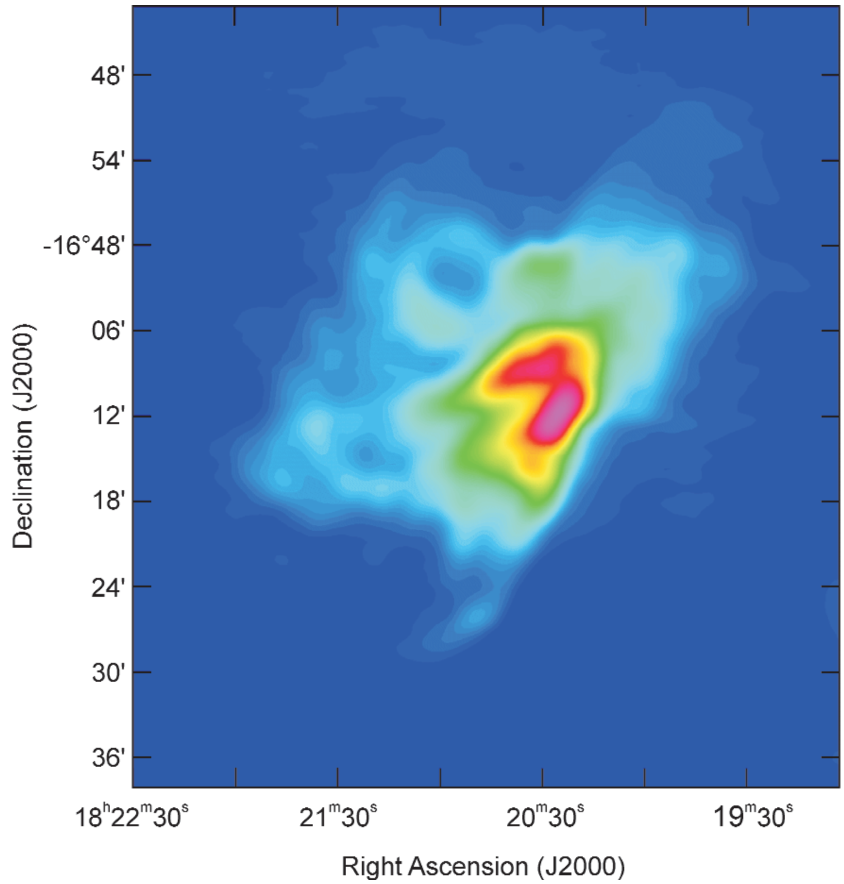
We are now making the first holography maps of the GBT surface using the 12 GHz holography receiver and transponder signals from geosynchronous satellites. This technique provides high signal-to-noise and thus allows maps over large areas, which can be transformed into high-resolution phase maps of the surface of the GBT. These phase maps will, in turn, be converted to a table of actuator corrections. In addition, a group from Mullard Radio Astronomy Observatory Cambridge (UK), Richard Hills, Bojan Nikolic, and John Richer, has been analyzing the surface of the GBT using the "out-of-focus" or "phase retrieval" holography technique. In this technique, strong cosmic sources are mapped at two or more focus positions, and phase maps of the surface are constructed. The technique is valuable because it can be used with astronomical sources using any facility receiver, and allows determination of large scale structure of the surface over a range of elevation angles. Only preliminary results have been obtained to this point, but they are very encouraging. (See *http://www.mrao.cam.ac.uk/~bn204/ gbtoof/oofgbt.html*.)

We continue to work on the Precision Telescope Control System (PTCS), which is required for efficient observations in the 7 mm and 3 mm wavelength bands. The PTCS combines the laser metrology system, active surface system, and subreflector positioning systems into an integrated unit operating as part of the telescope monitor and control system. The current emphasis is on installing the quadrant detector system that measures the position of the feedarm, and on developing an engineering measurement system that can be used to accurately survey key positions on the GBT structure and aid in calibrating the finite element model.

In the early months of commissioning, the GBT was controlled from the Servo Room on the alidade structure of the GBT. In late January, control of the GBT was moved to the Jansky Lab Control Room, as planned. Ample space and facilities exist for both the operator and observing team in the new Control Room, and the working environment is much improved. Location in the Jansky Lab also allows improved access and communication with the technical support staff.

A number of significant scientific results from the GBT have been obtained in recent weeks. Pulsar observations have been particularly fruitful. Several new millisecond pulsars have been detected by two groups (e.g., see the article on page 18 by Jacoby, et al.). Additional radar imaging of solar system objects was performed in December in conjunction with Arecibo Observatory. In late February, the GBT participated in a global VLBI program that included the VLBA, phased-VLA, Arecibo, and EVN stations. The GBT is now able to process VLBA observing files and command its observations accordingly. The best-ever continuum image of the Orion nebula at 8 GHz has been obtained through combined observations by the GBT and VLA (see the article on page 5 by Shepherd, Maddalena, and McMullin). A number of other striking images have been obtained during commissioning, such as the Omega Nebula (M17) image displayed in the figure shown here.

P. R. Jewell



An 8.4 GHz continuum image of the Omega Nebula (M17) obtained during commissioning by R. Maddalena and F. Ghigo. The image was taken in an on-the-fly observing mode with the DCR continuum backend and was reduced with AIPS++. Little image processing has been done on the data; a simple linear baseline was subtracted from each scan.

3 mm Bolometer Camera for the GBT

As part of the university-built instrumentation initiative, the NRAO is funding the development and construction of a bolometer camera to be built principally at the University of Pennsylvania. The camera will be a 64-pixel array consisting of TES bolometers with SQUID readouts, in a 300 mK cryostat. The bolometer filters will be centered at approximately 3.3 mm wavelength (~90 GHz) and will have ~20 GHz of effective bandwidth. The sensitivity per pixel is expected to be < 1 mJy / rt-Hz. The camera design is that of an open array with full sky sampling (0.5 f*λ). The array will fully sample an area of approximately 0.5 arcmin square. The camera will belong to NRAO/NSF at the conclusion of the development, as a facility instrument, and will be available for general use by the community. The development time for the camera is approximately three years. The project was formally begun at the end of February 2002.

The project is a collaboration of the University of Pennsylvania, NASA-Goddard Space Flight Center, and the NRAO. UPenn is responsible for overall system design and construction, NASA-Goddard will supply the TES arrays, and the NRAO will provide mechanical and software development support. Mark Devlin (UPenn) is the principal investigator and project manager, and Simon Dicker (UPenn) is the project engineer. Dominic Benford (NASA-GSFC) is the detector engineer, Roger Norrod is the NRAO engineering coordinator, and Phil Jewell is the NRAO project manager.

Scientific targets for the camera will include dust emission from high redshift galaxies, Sunyaev-Zeldovich effect observations, dense dust cores in Galactic star-forming regions, and trans-Neptunian solar system objects, among others. Atmospheric transparency surveys indicate that typically ~100 days per year should be suitable for 3 mm observations in Green Bank, occurring mostly during the period from October through April.

P. R. Jewell

GBT Instrument Development Program

There are many opportunities to expand the scientific potential of the GBT through instrument development and technology innovation. The Observatory has funded several internal development projects this year for the GBT through its Research Equipment Program. These projects, described below, emphasize imaging capability and the coverage of frequency ranges not included in the initial suite of GBT instruments.

Beam-Forming Array. This instrument will provide a full-sampling array of 7-19 beams on the sky in the 18-21 cm band (L-band). The instrument works by sampling the electric field in the focal plane with a number of close-packed, planar feeds and receiver sets. The signals are correlated with appropriate weighting to fully sample an area of the sky. This project is a five-year program that requires some initial technology development. The instrument should increase the speed of HI and OH spectral line imaging and pulsar detection surveys.

3 mm Receiver. This receiver will cover ~68-92 GHz with a dual-beam, dual polarization, pseudo-correlation system. The receiver will be effective for both spectral line and continuum work, and will have ~20 GHz of continuum detection bandwidth. The receiver has passed its preliminary design review and will require approximately a year to complete. A second phase of the project, not yet funded, will include another set of receivers covering the 90-116 GHz range. The receiver will allow spectroscopy of Galactic and extragalactic molecular species, and high-sensitivity continuum observations of dust and other emission sources. The dual-beam configuration will give optimum sensitivity for point source work.

1 cm Receiver. This receiver will cover ~26-40 GHz, and will have a similar design to that of the 3 mm receiver, i.e., a dual-beam, dual-polarization, pseudo-correlation system. The 3 mm and 1 cm receivers will share a common IF down-conversion system. This receiver has also passed its preliminary design review and will be constructed over the next year. The 1 cm receiver will be optimized for high redshift CO and continuum point source observations.

Additional projects funded this year include continued work on the Precision Telescope Control System, a program of RFI mitigation on GBT systems, and some smaller projects.

P. R. Jewell

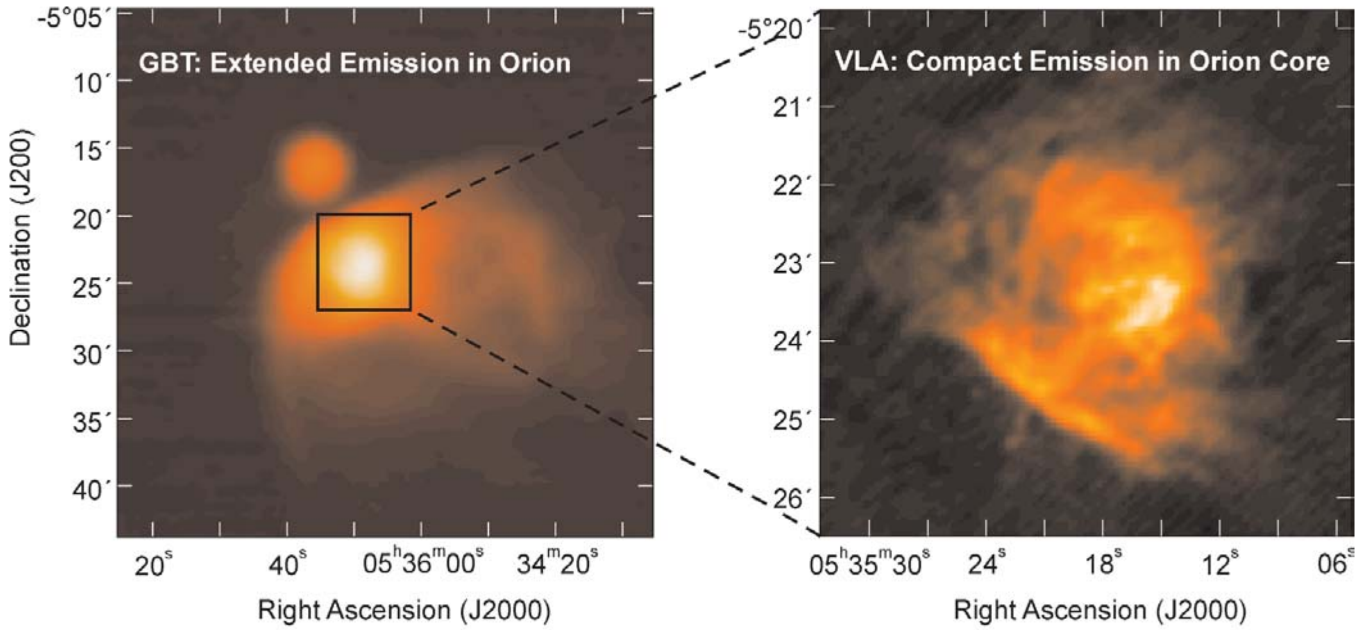
The Orion Nebula in 3.6 cm Continuum Emission

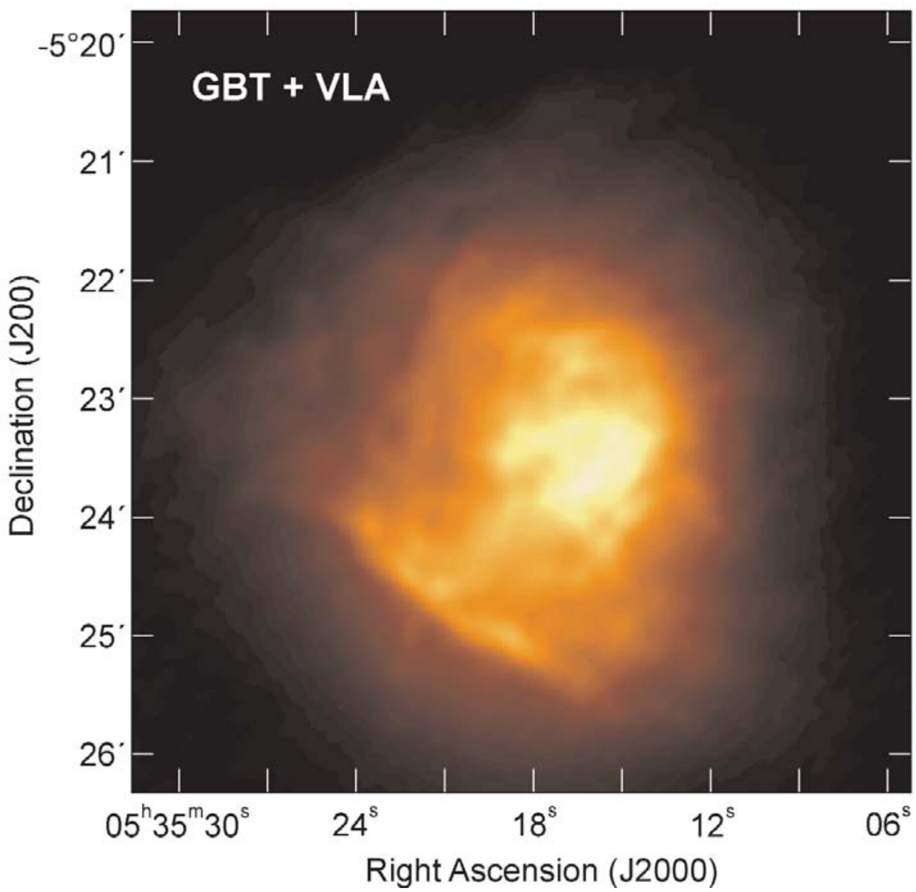
Free-free continuum emission from ionized gas in the Orion Nebula was imaged at 3.6 cm (8.4 GHz) with the Robert C. Byrd Green Bank Telescope (GBT), which recovers extended emission, and the Very Large Array (VLA), which images compact structure. The two images were then combined to create an image of the core of the Orion Nebula that recovers all flux while preserving the resolution. The goal of this project was to develop a straight-forward method of combining GBT and VLA data in a repeatable and robust fashion to obtain high fidelity images. The results presented here represent the first step in this process.

The GBT image was taken in an 'on-the-fly' (OTF) raster mode on 2001 November 1. The image was sampled every 25'' along a row while rows within the mosaic were spaced by 30''. The bandwidth was 80 MHz. The primary beam of the GBT is 1.46' at 8.4 GHz. The central region in the nebula was imaged with the VLA in the compact D-array. The shortest baseline of 35 m corresponded to a largest angular scale of approximately 2'. Observations of the 3 x 3 field mosaic were made on 2000 October 4; field centers were separated by 2.5' (slightly better than Nyquist sampled). The band width was 50 MHz. The primary beam of a single pointing was 5.4', the synthesized beam was 8.4''.

The GBT and VLA data were reduced and imaged in AIPS++. The figure on the following page shows the GBT image in the upper left displayed from 0 to 119.4 Jy/beam. The OTF mosaic has an RMS of 10 mJy/beam and a maximum of 119.4 Jy/beam. The dynamic range of the image is 11,900—the highest dynamic range ever achieved by a single dish telescope. The total flux = 430 Jy. The VLA image (upper right) is displayed on a linear stretch from 0 to 0.83 Jy/beam. The mosaic has an RMS of 6.1 mJy/beam, a maximum of 0.83 Jy/beam, and a minimum of -0.027 Jy/beam. Total flux = 189 Jy – less than half the total flux measured with the GBT. The combined GBT+VLA image (bottom center) was created in AIPS++ using an "image feathering'' technique: each clean image was automatically Fourier transformed to the UV-plane, weighted appropriately, combined, and then Fourier transformed back to the image plane. The resulting image has a peak flux density of 1.82 Jy/beam, an RMS of 10 mJy/beam, and a total flux of 415 Jy.

The GBT image is dominated by the brightest nebula, M42 (NGC 1976); M43 (NGC 1982) is just above the north-eastern rim of M42. Emission features in a low-surface brightness thermal radio halo from M42 (Wilson et al. 1997); Subrahmanyan, Goss, & Malin 2001) correspond to shock fronts traced by [SII] emission (Bally & Reipurth 2001). The





VLA image shows that numerous bright rims and filaments of emission dominate the fine-scale structure in the Orion core. The base of the ionized gas feeding the extended halo is visible, however most of the flux is not recovered. The GBT+VLA image shows that the fine structure is embedded in a complex distribution of more extended emission.

References:
Bally, J. & Reipurth, B. 2001, ApJ, 546, 299
Subrahmanyan, R., Goss, W.M., & Malin, D.F. 2001, ApJ, 121, 399
Wilson, T.L., Filges, L., Codella, C., Reich, W., & Reich, P. 1997, A&A, 327, 1177

D. S. Shepherd, R. J. Maddalena, & J. P. McMullin

Green Bank Linux Server Available for GBT Data Reduction and to NRAO Scientific Staff

In anticipation of the high data-rate available from the Green Bank Telescope, NRAO recently purchased a multiprocessor Linux server (details below). The specific intent of this machine is to allow processing of large GBT data sets (pulsar observations or large on-the-fly maps for example) that cannot easily be handled with a standard workstation.

Once the GBT is fully scheduled, we anticipate this machine will be assigned to observers in a manner similar to the computing facilities at the AOC in Socorro. In the meantime, we propose to make spare capacity available on a more *ad hoc* basis; to both GBT observers with large GBT data-sets, and to members of the scientific staff from any NRAO site.

If you would like to make use of this machine, please send me a short email (*rprestag@nrao.edu*) detailing anticipated usage (disk and cpu) and preferred timescale. I will then make arrangements on a case by case basis. Note that our off-site network bandwidth is very limited; data transfer will most likely have to be via tape. If demand becomes too large, we will simply move to a more formal booking scheme sooner rather than later.

Machine details: Dell PowerEdge 8450 with eight 700MHz processors (2Mb cache); 8Gb RAM (max 3Gb per process); 600GB raid array; DDS-4, DLT 7000 and LTO tape drives; RedHat 7.2 O/S.

R. M. Prestage

EVLA

Work on the Expanded Very Large Array project continues on many fronts. The preliminary design reviews (PDRs) on major parts of the project continue, with the LO/IF System review held January 22-23, and the Front End and Feed System review held February 12-13. All materials presented at design reviews, and the reports from them, can be accessed from the website *www.aoc.nrao.edu/evla/pdrs.shtml*. There remain three more PDRs: the Monitor and Control System Hardware (March 13), Monitor and Control System Software Review (May 14-15), and the Overall Data Processing Architecture Review (July 15-16).

The project is nearly ready to purchase its first major component—the fiber optic cable. The Fiber Installation CDR (Critical Design Review) is scheduled for May 9, and actual installation of fiber to all existing VLA pads should begin in the fall.

Design and protyping in all areas continues, with a goal of outfitting and testing on a test antenna, beginning in April 2003. At that time, one of the existing VLA antennas will be withdrawn from service, and outfitted for specific performance testing of the proposed new electronic systems. Only after a period of intensive testing will the project be able to proceed with critical design reviews of all major components, and subsequent outfitting of the entire array.

The first meeting of the EVLA Advisory Committee is scheduled for June 10-11, 2002. The committee consists of 11 scientists appointed by, and reporting to the NRAO Director. Committee members are listed on the EVLA Advisory Committee website: *www.aoc.nrao.edu/evla/admin/advcom/advcom.html.* We encourage all individuals with concerns about the project to contact a committee member.

Preliminary work on the completion of the EVLA continues with identification of potential sites for 'Phase II' antennas. Earlier designs were based solely on simple concepts of antenna spacing and separation, and did not take into account practicalities such as road access, power, land ownership, and access to fiber optic lines. The current effort has taken all these important factors into account, and has resulted in a number of proposed configurations which are currently being software-tested for their imaging performance.

R. A. Perley, P. J. Napier

NEW MEXICO OPERATIONS

Organization of New Mexico Operations

Since Miller Goss has stepped down as Assistant Director for New Mexico Operations, we have made some modifications in the local organization. Mark McKinnon will remain as the sole Deputy Assistant Director with oversight of the Electronics and Engineering Services Divisions, as well as assisting with all aspects of VLA/VLBA Operations. Mark moved from a similar position in Green Bank in mid-2001.

Greg Taylor has been appointed the new Division Head for Scientific Services. In this position, Greg will take over supervision of the VLBA test meeting, represent NRAO in international VLBI activities, and coordinate the VLA and VLBA support activities of the Scientific Services Division. In addition, I have asked Greg to be responsible for tracking our progress in fulfillment of the recommendations of the NRAO Users Committee and the Visiting Committee.

It is a pleasure to be working with Mark and Greg in their new capacities.

J. S. Ulvestad

Opportunities for Collaboration on VLA and VLBA

We invite current or potential users of the VLA and VLBA to ask for a collaborator on the NRAO scientific staff. This is of particular interest for those who are new to using one or the other telescopes, and would like help in coming up to speed to write proposals to achieve their scientific goals. To aid in finding someone on the staff with similar scientific interests we have created a new web page at *http://www.aoc.nrao.edu/AOC/AD/aoc-research.html* listing the interests of the scientific staff, along with their contact information. To solicit a collaborator for a VLA or VLBA project contact the person whose interests best match your project, or send an inquiry to the Socorro A.D. - Jim Ulvestad (*julvesta@nrao.edu*), or the Socorro Division Head of Scientific Services - Greg Taylor (*gtaylor@nrao.edu*).

J. S. Ulvestad, G. B. Taylor

VLA Configuration Schedule; VLA / VLBA Proposals

Configuration	Starting Date	Ending Date	Proposal Deadline
A(+PT)	25 Jan 2002	06 May 2002	1 Oct 2001
BnA	17 May 2002	03 Jun 2002	1 Feb 2002
B	07 Jun 2002	03 Sep 2002	1 Feb 2002
CnB	13 Sep 2002	30 Sep 2002	3 Jun 2002
C	04 Oct 2002	30 Dec 2002	3 Jun 2002
DnC	10 Jan 2003	27 Jan 2003	1 Oct 2002
D	31 Jan 2003	03 May 2003	1 Oct 2002

GENERAL: Please use the most recent proposal cover sheets, 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. Only black-and-white reproductions of proposal figures will be forwarded to VLA/VLBA referees.

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 90 cm (solar and other interference; disturbed ionosphere, especially at dawn), deep 20 cm observations (solar interference), line observations at 18 and 21 cm (solar interference), polarization measurements at L-band (uncertainty in ionospheric rotation measure), and observations at 2 cm and shorter wavelengths in B and A configurations (tropospheric phase variations, especially in summer). Proposers should defer such observations for a configuration cycle to avoid such problems. In 2002, the C configuration daytime will involve RAs between 10^h and 20^h and the D configuration daytime will involve RAs between 19^h and 05^h. Note that this implies that we shall accept few C configuration proposals for HI observations of galaxies in the north galactic cap.

75 MHz feeds impair the efficiency of the 21 cm feed and so are removed for much of the time. They will be installed during the BnA configuration and the early part of the B configuration only.

Approximate Long-Term Schedule

	Q1	Q2	Q3	Q4
2002	A	A,B	B	C
2003	D	D,A	A,B	B
2004	C	D	D,A	A
2005	B	B,C	C	D
2006	D,A	A	B	C

There has been an often expressed desire that the VLA have dynamic scheduling to better match high frequency proposals to the weather. The necessary software to handle the bookkeeping for this has been proceeding at a slow pace. It is hoped that we will have a brief test of the concept during the reconfiguration from CnB to C configuration in October.

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 10-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. Scheduling prospects also are enhanced for dynamics requesting only 2 to 3 hours of time away from popular RAs (currently popular RAs are 3-5^h, 9^h, 12^h, 16^h 18-20^h, and 22^h). See *http://www.aoc.nrao.edu/vlba/schedules/ this_dir.html* for a list of dynamic programs that 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. 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.

B. G. Clark

VLBI Global Network Call for Proposals

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

Date	Bands	Proposals
24 May to 14 Jun 2002	6 cm, 18 cm, other?	01 Feb 2002
08 Nov to 29 Nov 2002	6 cm, 18 cm, other?	03 Jun 2002

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. In general, 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 JIVE correlator 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 JIVE correlator 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 cover sheet, which can be retrieved at *http://www.nrao.edu/administration/directors_office/vlba-gvlbi.shtml*. Proposals may be submitted electronically in AdobePostscript format. For Global proposals, those to the EVN alone, or those requiring the Bonn correlator, send proposals *toproposevn@hp.mpifr-bonn.mpg.de*. For proposals to the VLBA or Global proposals, send proposals to *propsoc@nrao.edu*. Please ensure that the Postscript files sent to the latter address request U.S. standard letter paper. Proposals also may 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.

B. G. Clark

VLBA Calibration Service

The NRAO is setting up a VLBA data calibration service, mainly intended for novice VLBA users. Currently VLBA-only, single or dual polarization continuum data at multiple frequencies between 1.4 and 15 GHz can be calibrated in a semi-automatic way in AIPS, providing FITS files that are fully calibrated, including fringe-fitting and beyond. The user can start imaging the individual sources (maybe after some data flagging) right away. At the moment, selected calibrated FITS files are distributed along with (but not instead of) the normal VLBA correlator distribution tapes and first tests involving the VLBA user community are being reviewed.

The service can be requested by novice users by checking item 16 on page two of the VLBI proposal cover sheet. Gradually the service will be extended to more complex observations (spectral line, polarization, high-frequency, and including the VLA, Effelsberg, and perhaps other non-VLBA antennas) and may be made available to more experienced VLBA users at a later stage or upon request. Questions and suggestions are welcome to *lsjouwer@nrao.edu.*

L. Sjouwerman

NRAO-NM Computing

In the previous newsletter, the arrival of eight new Linux dual-processor public machines was announced. Their AIPS mark per processor ranges between 80 (for the traditional DDT) and 84 (for the more recent Y2K). They replace 10 much less powerful Sun Solaris workstations. For applications that absolutely require the Sun Solaris operating system we have kept our two most powerful public Suns, which in the course of 2002 we hope to replace with new, much faster Sun Solaris machines. Although the absolute number of public machines has decreased from 12 to 10 (primarily dictated by increasing demands on office space), the average public workstation is far more powerful than before. For the current fiscal year we don't expect to further upgrade our public machines. We intend, though, to keep modernizing public peripherals such as tape drives. We also plan to upgrade the publicly available machines in the VLA control building.

We modernized the web page showing the public workstation bookings. To reach that page, from the NRAO homepage go to "Sites and Telescopes," "Socorro," and "Workstation Bookings" in the "Socorro Visiting Scientists Information Package" paragraph. No logging on is required to browse its contents.

The release of JObserve 1.6.5 now is scheduled to take place in March 2002. This will be a major bug fix release, addressing most items in the current "known bugs" list. Check the JObserve download page (*http://www.aoc.nrao.edu/software/jobserve/download/*) for the presence of files such as jobserve-1.6.5-linux.tgz.

G. A. van Moorsel

VLA/VLBA Proposal Submission Changes

We have made a fairly major overhaul to the cover sheet for VLA proposals. One of the most important changes is an addition that requests the e-mail addresses of all authors. By the end of this year, we hope to be sending out scheduling committee results by e-mail rather than on paper since a number of proposers have complained about the late notifications they receive by paper mail. Other changes include a reduction in the number of scientific categories and types of observation, a request that proposers specify whether their proposal is suitable for dynamic scheduling, and an overhaul of the source table to enable better specification of multichannel continuum setups and dynamic range requirements. At this writing, LaTeX and Postscript versions of the new cover sheet are available at *http://www.nrao.edu/administration/directors_office/tel-vla.shtml*. Please note that the format has been converted from TeX to LaTeX, making it much simpler to incorporate the scientific justification and figures. A revision of the VLBA cover sheet and its conversion to LaTeX also are under consideration, though this change would be a bit more complex because the VLBA and the European VLBI Network share a common cover sheet. Potential proposers are reminded that the Observational Status Summaries for the VLA and VLBA (available on the web) are important resources in proposal-writing; the VLA Observational Status Summary was just updated in February.

One important item now has been bold-faced at the bottom of the VLA cover sheet, namely the statement that the Scientific Justification should be "not in excess of 1000 words." At recent deadlines, it has become increasingly common for proposers to submit justifications of 1200 or 1300 words, sometimes 1500 or 2000. Since we receive an average of 200 VLA and VLBA proposals per deadline, this places an undue burden on the referees and the scheduling committee. Therefore, beginning with the June deadline the referees and scheduling committee are being advised that they may downgrade both VLA and VLBA proposals in which the scientific justification for the observations is not clearly and concisely expressed within the 1000-word limit.

Finally, there has been some confusion about the nature of target-of-opportunity proposals that may be submitted for the VLA and VLBA. Specifically, some proposers have been uncertain about when they should submit a proposal via the normal refereeing process and when they should submit an *ad hoc* proposal outside that normal process. We have attempted to clarify our guidelines, which are common to both the VLA and the VLBA. The new instructions can be found at *http://www.aoc.nrao.edu/vlba/html/targetop.html*. Potential proposers should be advised that target-of-opportunity proposals submitted outside the normal process, and requesting more immediate scheduling, will be held to a very high scientific standard by the scheduling committee.

J. S. Ulvestad

Large VLA and VLBA Proposals

The VLA and VLBA Large Proposals policy has been described in *NRAO Newsletter* No. 83, with a modification for VLBA proposals described in *Newsletter No. 89*. As a reminder, "Large Proposals" are defined to be those requesting approximately 300 hours or more (see

Newsletter No. 83 for further details). VLA Large Proposals are collected and then reviewed once per 16-month configuration cycle, while VLBA large proposals may be submitted at any deadline. The last VLA deadline was May 15, 2001, for the cycle beginning with the A configuration in January 2002.

In order to continue the 16-month cycle, we are announcing that the next deadline for VLA Large Proposals will be October 1, 2002. The large proposals must reach the Director's Office in Charlottesville, by 5 p.m. EDT on that date. These proposals will be considered for scheduling in the configuration cycle beginning with the A configuration in May 2003. More information on large proposals can be found on the web at *http://www.nrao.edu/administration/directors_office/largeprop.shtml*

J. S. Ulvestad, B. G. Clark

The New Radio Universe

The NRAO will convene a topical session entitled "The New Radio Universe" on 2002 June 5 in Albuquerque, NM, during the 200th Meeting of the American Astronomical Society (AAS). The goal of this topical session is to update AAS members about exciting recent discoveries, at centimeter and millimeter wavelengths, that have enabled fundamental advances in key areas of modern astronomy and astrophysics. The topical session will involve four oral sessions plus an accompanying poster session. The schedule for the oral sessions appears below; all speakers have confirmed. Those who submitted poster abstracts to the AAS by the March deadline had the option of requesting that their poster be included in the accompanying poster session. Joan Wrobel and Jim Ulvestad are co-organizers of this topical session.

J. M. Wrobel, J. S. Ulvestad

Oral Sessions to be held June 5 at AAS Meeting

THE NEW RADIO UNIVERSE: Gas Motions Near Black Holes

Accretion Disk Structures, Black Hole Masses, and Cosmic Distances
- *Lincoln Greenhill, Harvard-Smithsonian Center for Astrophysics*

The Environs of Massive Black Holes and Their Relativistic Jets
- *Greg Taylor, National Radio Astronomy Observatory*

Microquasars
- *Michael Rupen, National Radio Astronomy Observatory*

Simulations of Relativistic Jet Formation
- *David Meier, Jet Propulsion Laboratory*

THE NEW RADIO UNIVERSE: Exploring High Energy Astrophysics

Gamma-Ray Bursts and Their Afterglows
- *Dale Frail, Caltech and National Radio Astronomy Observatory*

Active Galactic Nuclei in Nearby Galaxies
- *Heino Falcke, Max Planck Institut fuer Radioastronomie*

Large-Scale Jets from High-Luminosity Active Galactic Nuclei
- *Paddy Leahy, Jodrell Bank Observatory*

Gas in Galaxy Clusters
- *Tracy Clarke, National Radio Astronomy Observatory*

THE NEW RADIO UNIVERSE: Galactic and Extragalactic Star Formation

Initial Conditions for Star Formation
- *Neal Evans, University of Texas at Austin*

Disks and Outflows
- *Luis Rodriguez, Universidad Nacional Autonoma de Mexico*

Star Formation at the Galactic Center
- *Cornelia Lang, University of Massachusetts at Amherst*

Super Star Clusters and Starburst Galaxies
- *Kelsey Johnson, National Radio Astronomy Observatory*

THE NEW RADIO UNIVERSE: Cosmology and Galaxy Formation

High Redshift Galaxies
- *Chris Carilli, National Radio Astronomy Observatory*

The Cosmic Microwave Background and the Sunyaev-Zeldovich Effect
- *Tony Readhead, Caltech*

Gravitational Lenses
- *Chris Kochanek, Harvard-Smithsonian Center for Astrophysics*

HI in Galaxies: Clues to Galaxy Formation
- *Eric Wilcots, University of Wisconsin at Madison*

VLA Plays to Very Large Audience

"Star Tours Start Soon" announced the caption above a stunning photograph of a VLA antenna on the front page of the *Albuquerque Journal* on Monday, January 14. On Saturday, January 19, for the first time in more than a decade, 23 Socorro staff volunteers welcomed the public for guided tours of the Very Large Array, and the public responded exuberantly. 1500 guests toured the facility in groups ranging from 30 to more than 100. They were greeted at the Whisper Gallery by Assistant Director Jim Ulvestad, who entertained them with his now-famous Whisper Dish card trick. At the next stop, Clint Janes and Mark McKinnon explained the intricacies of cryogenics, front-end electronics, waveguides, and transporter trivia at the visitor antenna and the transporter. In the control room, Phillip Hicks, Mike Bradford, and Greg Patterson juggled questions about observations and array operations, and successfully performed a 5-subarray observation at the same time. Guests finished their tour with complimentary coffee and tea in the old cafeteria where they chatted with tour guides and shopped at the VLA portable gift shop.

A second round of tours was offered on Sunday, February 17. Using the same basic tour arrangement, but incorporating suggestions that followed the first round, we hosted 271 guests in 15 groups with an average size of 18. Crowd enthusiasm was just as prodigious as in the January tours, and there was much less wear and tear on our volunteers, especially the parking staff!

Future tours are set for Saturday, March 16, and Sunday, April 21. For the Education and Public Outreach sector, the goal of these tours is to gauge the level of public interest for future program and facilities planning. For the general public, the tours are an opportunity to see parts of the VLA not available on the self-guided walking tour as well as to have their questions answered and to get to meet and speak with people who work here.

R. J. Harrison

Former Assistant Director Miller Goss leads one of the first tours of the day on January 19.

IN GENERAL

Data Management

Important Computing Security Changes

Since the NRAO Computer Security Policy was issued two years ago, we have made a number of changes that have greatly reduced the risk of a serious computer break-in at the NRAO. One of the remaining steps to be taken primarily affects those who need to connect to NRAO computers from non-NRAO locations.

In past issues of the *NRAO Newsletter*, we described programs that use encryption to protect sensitive account information such as passwords, so that they are not exposed to network monitoring while one is making a connection. We encouraged our user community to begin using these programs, which are secure alternatives to commands such as telnet, rlogin, and rsh. Since early 2001, unencrypted access has been limited to a small number of systems at each major NRAO site.

This article is a reminder that, as announced in the January 2002 *NRAO Newsletter*, we intend to begin blocking all connections using telnet, rlogin, rsh, and rcp from non-NRAO systems. We note that other major astronomical centers, such as the NOAO, Jodrell Bank, and the Chandra X-ray telescope data center, have adopted similar policies with respect to such insecure connection protocols.

Effective July 1, 2002, when you wish to connect to NRAO systems from another location, you will need to use slogin, ssh, and scp under UNIX; several Windows and Macintosh implementations are also available (e.g. SecureCRT, putty, MacSSH). These programs are widely supported at academic and research institutions around the world, and are included in Linux. Please contact your local computer support staff if you are not sure of availability at your site.

We realize that there may be some inconvenience associated with this change, and are therefore providing advance notice so that you can prepare for it. This step will help to ensure the reliability and integrity of the computing environment for all users of our facilities.

If you have any questions or concerns about this change, please feel free to contact Ruth Milner, the NRAO Computing Security Manager (*rmilner@nrao.edu*).

M. R. Milner, P. P. Murphy

Windows XP Moratorium

Microsoft recently released a new version of its operating system, Windows XP. As we did with Windows 2000, we need to evaluate Windows XP and plan deployment carefully, without disrupting the transition to a Windows 2000 Active Directory environment that is already in progress. Until the Windows 2000 domain migration is well underway, and thorough evaluation of XP's technical and licensing features has been done, there will be a moratorium on the deployment of Windows XP on computers which connect to the NRAO networks. During this period, only those systems participating in tests may use the new operating system.

This moratorium will remain in effect until we are satisfied that deployment of Windows XP is prudent and will not adversely affect either the progress of Windows 2000 domain migration or the overall computing environment at the NRAO.

If you will be visiting the NRAO and plan to bring a laptop computer which runs Windows XP, please contact the PC support staff at the relevant NRAO site to find out whether you will be able to connect it to a test network there.

M. R. Milner, P. P. Murphy

Improvements to Web Services

In the January 2001 *NRAO Newsletter*, we alluded to a long-term goal of providing improved web service via a set of mirrored servers at each NRAO site. We are happy to report progress on this front. Four identical Linux servers equipped with significant RAID-based disk storage, processing power, and memory, have been purchased to achieve this end, and the first one is now in production in Charlottesville. This new machine is serving a total of six virtual servers, including *www.nrao.edu*, *www.cv.nrao.edu*, *www.alma.nrao.edu*, and the NRAO mailing list service *listmgr.cv.nrao.edu.*

Over the next few months, we will deploy and test the mirroring scheme in Charlottesville, and then deliver the other three servers to Green Bank, Socorro, and Tucson. Following their installation, we will enable web service for *www.nrao.edu* to be shared transparently by the four systems. The automatic mirroring will be used to keep the web content synchronized. We expect this to significantly improve NRAO web accessibility, performance, and capabilities, both within NRAO and to the rest of the Internet.

M. R. Milner, P. P. Murphy

Change to AIPS FILLM Task

The 31DEC01 version of the task FILLM had a major addition made to it on September 21, 2001. This task translates a VLA archive data set into AIPS format on disk. By default, it now reads in the weather station data, creating a WX table. It uses these data and a standard VLA antenna gain table (now provided with AIPS) to put opacity and antenna gain corrections into the initial calibration (CL) table. This action is selected by default and may be modified or turned off with BPARM input parameters. This first CL table then needs to be applied to the data during the calibration process, an action that could be ignored previously for VLA data.

E. W. Greisen

New AIPS Home and Midnight Job

The center of the AIPS universe has been the computer called kochab in Charlottesville. It housed the master repository for the code and documentation and served copies of both frozen and development versions to all sites that requested them. However, kochab has become rather "long in the tooth" and in need of replacement. Since all of the AIPS programming effort now is concentrated in the AOC in Socorro, it was decided to move the main web site and code repository to a Linux computer in the AOC. The machine chosen is known as mnj.aoc.nrao.edu (to mnj users) or lcomp (Linux compiler host) or bob (to its friends). There is now a full code repository on "bob" that is maintained by using aips tools running on top of the rcs code maintenance system.

To obtain a copy of AIPS, the user (or AIPS Manager) at some remote site first visits the new AIPS web site at *http://www.aoc.nrao.edu/aips* for instructions and information. From that web site, the manager may download a frozen copy of the 31DEC01 version of AIPS or today's copy of the 31DEC02 version, which remains under development. A tool called install.pl is downloaded as well and is run to install the selected version. There is a set of procedures which may be run to keep a 31DEC02 version of AIPS current with the master copy. These "midnight job" (MNJ) procedures have been partly rewritten by Stephan Witz so that they use the cvs code versioning system to make the versions of all files at the remote site match those at the master. Unlike the previous version, the secure shell is not needed by cvs; it has its own excellent security measures. Therefore, one does not have to install and maintain magic keys in order to enable the MNJ. We were amazed to discover that a site in Japan installed 31DEC02 and got the MNJ running, before we even had the MNJ operating inside the AOC. We expect that it now will be much easier for sites to run the latest AIPS version and to remain in synch with it.

E. W. Greisen

Summer School in Spectrum Management for Radio Astronomy

NRAO is hosting a Summer School in Spectrum Management for Radio Astronomy, at Green Bank from June 9 to June 14, 2002. The summer school is organized by IUCAF, which is the body that represents the interests of Radio Astronomy and Space Science at international frequency allocation meetings. The purpose of this Summer School is to offer, for the first time, a comprehensive view of both technical and regulatory issues related to radio astronomers' use of the spectrum. The intended audience are members of the radio astronomy and related radio engineering community who are active, or who are interested in becoming active in this area at the local, national, or international level.

Further details, including a registration form, can be found at: *http://www.iucaf.org/sschool/*. Completed registration forms are requested, preferably electronically to *spectman@iucaf.org*, by March 31. Some funds may be available for help with travel and other expenses of participants.

Any questions may be addressed to Darrel Emerson (*demerson@nrao.edu*). Further information about IUCAF may be found at *http://www.iucaf.org/*.

D. T. Emerson

New Preprint Policy

It has been a long-standing NRAO policy that all staff and visiting observers are required to provide the Charlottesville library with four paper copies of any preprint for which NRAO will be asked to pay page charges. This policy has satisfied three needs: it provided paper preprint copies for the library shelves in each of the four library branches, it provided a paper copy for the librarian to use in processing the associated request for support of page charges, and it provided a record of an NRAO publication for use in the annual report which goes to the NSF and for the statistical information used by NRAO administrators. Although a significant number of staff at all sites prefer reading preprints in paper and like to see preprints on the incoming mail shelves, there is also a number who much prefer the astro-ph format.

Beginning April 1, 2002, we will allow authors the option of providing either: 1) the usual four paper copies of their preprint, or 2) the astro-ph link to their preprint, or 3) both paper and the link. Note that if you provide the astro-ph link only, no paper copies of your preprint will be printed and displayed at the NRAO site libraries.

Paper preprints should be sent to the Library at the Charlottesville address; the astro-ph link should be emailed to library@nrao.edu

E. N. Bouton

2002 Summer Student Research Program at the NRAO

There are two types of Summer Student programs available at the NRAO. The first is for undergraduates who are U.S. citizens enrolled at a U.S. undergraduate institution and is funded largely by the National Science Foundation (NSF)'s Research Experiences for Undergraduates (REU) program. The second is for graduating seniors, or first or second year graduate students enrolled in an accredited Graduate Program, funded by the NRAO Graduate Summer Research Program. In both of these programs, the student spends 10-12 weeks over the summer working closely with an NRAO mentor on a research project.

During the summer of 2002, there will be about two dozen students spread about the four NRAO sites engaging in research projects with NRAO mentors. Fifteen of the positions are supported by the Research Experiences for Undergraduates program under an NRAO grant from the National Science Foundation. The ten remaining positions are available for graduating seniors and graduate students who are interested in learning the techniques of radioastronomical research. Twenty-two of the positions were filled within a week after the offers were made (on March 1) to students selected from the 110 applications received. The deadline for receipt of applications for next year is January 24, 2003; instructions for applying may be found at *http://www.nrao.edu/education/students/.*

H. A. Wootten

2001 summer students get a "close-up" view of a VLA antenna.

NEW RESULTS

Discovery of Water Molecules and a Magnetized Torus in the Planetary Nebula K3-35

K3-35 is an emission line nebula discovered by Kohoutek (1965) and included in his third list of planetary nebulae (PN). However, the nature of K3-35 was controversial for many years. The detection of OH and water maser emission toward this object (Engels et al. 1985) and the coincidence along the same line-of-sight of K3-35 and the dark cloud L755 suggested that K3-35 could be a young stellar object (YSO). On the other hand, the spectral energy distribution (Aaquist & Kwok 1989), the presence of a broad CO component (Dayal & Bieging 1998), and some properties of the OH maser emission (Engels et al. 1985) suggested a PN nature for K3-35. Moreover, the radio continuum maps obtained with the Very Large Array (VLA) (Aaquist & Kwok 1989; Aaquist 1993) revealed an extreme point-symmetric S-shape, which was unique at that time, and raised new questions about the nature of the object.

Motivated by the peculiar radio continuum morphology, we began to observe K3-35 in 1997 at optical and radio wavelengths (Miranda et al. 1998, 2000). A combination of the optical and radio data showed that K3-35 consists of a precessing bipolar jet emanating from a bright compact core, embedded in an elliptical envelope (size 10”) with a dense equatorial torus. The optical spectroscopy was crucial to establish the nature of K3-35. The very strong [NII] 6548+6583 emission lines (five times more intense than the Hα emission), the presence of the HeII 4686 emission line (with an intensity about half that of the Hβ emission), very strong [OIII] 4959+5007 emissions and moderately weak [OI] and [SII] emissions imply physical conditions in the ionized nebula and in the exciting star that are impossible in YSOs but unambiguously indicate a PN nature. Moreover, in the IRAS two-colour diagram, K3-35 is located in the PN region and not in the YSO region.

However, the PN nature of K3-35 and the detection of water masers toward the object were difficult to reconcile. Water maser emission is typical of red giant, AGB and post-AGB stars, but when photoionization begins and the star enters its PN phase, water molecules are photodissociated in a very short time ($\lesssim$100 years, Gómez et al. 1990); so, the presence of water and hence water maser emission was unexpected in a PN. The water maser emission could be easily understood, however, if it arises in a YSO associated with the background L755 cloud, and not in K3-35. In fact, the angular resolution of the previous water maser observations (40”; Engels et al. 1985) was not high enough to conclusively establish whether the water masers were associated or not with K3-35. In an attempt to solve this mystery, we observed K3-35 using the VLA in its A configuration. Simultaneous observations of the continuum emission at 1.3 cm (as a tracer of the ionized envelope) and of the water maser emission were carried out. This technique, extensively applied to YSOs (e.g., Torrelles et al. 1996), provides not only high spatial resolution but also an accurate register between the maser positions and the ionized material. In addition, the OH 1665 and 1667 MHz maser lines, as well as the 3.6 cm continuum emission were observed.

The VLA observations revealed that the water maser emission clearly arises from K3-35, representing the first confirmed detection of water in a PN. These results, that we reported in a recent issue of *Nature* (Miranda et al. 2001), are illustrated in Figure 1. Water maser emission is observed toward the core of K3-35, probably tracing the innermost regions of the torus, at a distance of 85 AU from the center (adopting a distance of 5 kpc to the source; Zhang 1995). To our surprise, water emission was also detected at the tips of the bipolar lobes, at the enormous distance of 5000 AU from the center, and tracing a bipolar outflow. This distance is a record among evolved objects. Furthermore, K3-35 is, to our knowledge, the first cosmic source in which water emission is observed at the tips of bipolar lobes. The association of the distant water masers with the precessing jets of K3-35 strongly suggests that the jets are involved in their excitation. The presence of water indicates that K3-35 is an extremely young PN. The dynamical age for the ionized region where HeII arises, inferred from the expansion velocity deduced from this emission line and the distance of the maser spots to the center, is only ~15 years, which is compatible with the absence (or extreme weakness) of the HeII 4686 emission in a spectrum obtained in 1986 (Acker et al. 1992). All these results indicate that K3-35 is being observed at the very moment of its transformation from a red giant to a PN.

The OH 1665 and 1667 MHz lines are both detected toward the center of the nebula, but with a different distribution (Figure 1). The 1665 MHz emission arises in a band tracing the torus of K3-35 whereas the 1667 MHz emission appears in two groups with an orientation similar to that of the collimated outflow. Remarkably, the OH 1665 MHz emission exhibits a high degree of circular polarization (~50%) that indicates the presence of a magnetic field of milligauss strength in the torus. This is the first detection of a magnetized torus in a PN, which is a basic ingredient in recent models for the formation of jets in these objects (Rozyczka & Franco 1996).

A number of important questions arise after the detection of water maser emission in K3-35. In particular, the existence of the distant water molecules is puzzling. Water masers were not expected at such an enormous distance from an evolved star, where the physical conditions to pump the water maser emission are not supposed to exist.

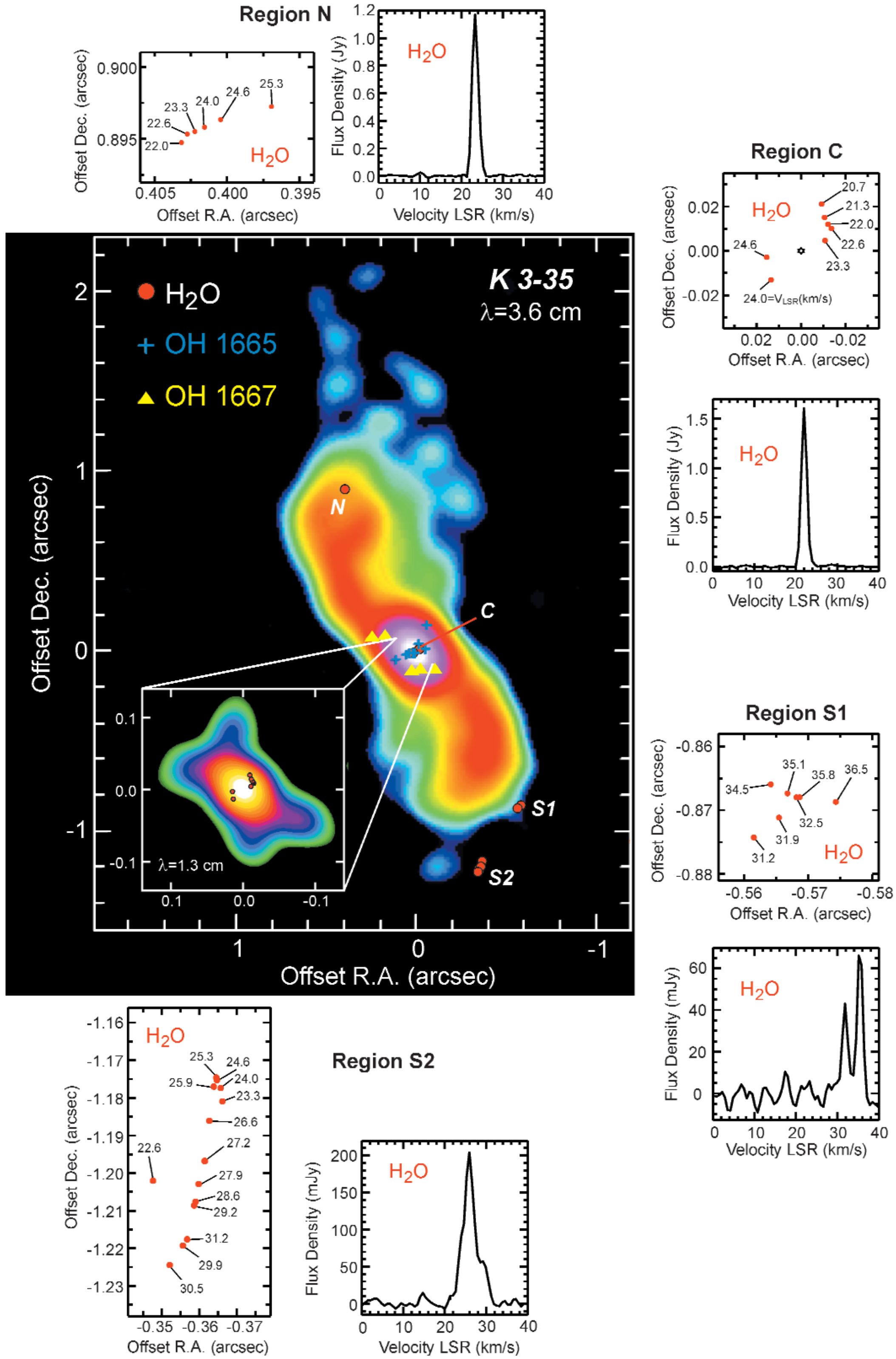


Figure 1. Water maser and OH maser emission in the planetary nebula K3-35 (figure adapted from Miranda et al. 2001). The color images show the 3.6 cm and 1.3 cm (inset) continuum emission, which trace the ionized nebular material. A bright core, with an incipient hour-glass morphology at 1.3 cm, and two bipolar lobes, whose brightest parts correspond to the precessing bipolar jet, can be distinguished. Red dots in the figure represent the positions of the H_20 maser spots. The detailed spatio-kinematical structure and the spectra of the water maser emission are shown in the panels for the four regions (N, C, S1 and S2) in which water emission is detected. The blue crosses mark the positions of the OH 1665 MHz maser spots, and the yellow triangles mark the positions of the OH 1667 MHz maser spots. The peak position of the 1.3 cm continuum emission, at R.A. (2000) = $19^h\ 27^m\ 44.023^s$ and Dec (2000) = 21°30'3.44", is the reference (0,0) in all the images.

Although the precessing jets in K3-35 may be related to the excitation of the distant water masers, the presence and persistence of water molecules in these regions seem to require a shielding mechanism against ionizing radiation (Miranda et al. 2001). Moreover, the results obtained also have strong implications for our knowledge of the transformation processes of a red giant into a PN: is the presence, persistence and spatio-kinematical distribution of the water masers observed in K3-35 a common phenomenon at the beginning of the PN phase? Or, on the contrary, is K3-35 a singular PN in which distant water masers survive because of some peculiar, still unknown, shielding mechanism? A full understanding of this new phenomenon requires the identification and characterization of water masers in other PN, as well as detailed modeling studies. K3-35 further shows that magnetized toroids in PN are not only a theoretical speculation but a reality. Thus, K3-35 offers an excellent opportunity to study the properties and role of magnetic fields in the formation of PN.

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GBT's First Pulsar Discoveries: A Treasure Trove of Three New Millisecond Pulsars in the Rich Globular Cluster M62

Globular clusters, self-gravitating clusters of stars, are the most ancient sub-units of our Galaxy. As such these objects have been studied intensively so as to gain a view of our very distant past. The discovery of bright X-ray sources by the pioneering X-ray Uhuru mission showed the presence of accreting neutron stars. That these systems eventually descend to “recycled” pulsars became a working principle with the discovery of the first millisecond pulsar in 1982 at Arecibo. Eventually, the first globular cluster pulsar was discovered in 1987 at Jodrell Bank.

Cluster research was heavily concentrated at Arecibo and later at Parkes (with which the richest clusters can be observed). The current census stands at nearly sixty cluster pulsars spread over nineteen clusters. For quite some time it has been recognized that cluster pulsars offer unique perspectives on the mass distribution within the very core of clusters and into tidal astrophysics, and provide the most sensitive diagnostic of intra-cluster gas. The first two “applications” require and benefit from having multiple pulsars in the same cluster.

The dense clusters found in the galactic bulge are thought to have the richest population of radio pulsars. The bulge clusters cannot be accessed from Arecibo (being located in the deep South) and astronomers anxiously awaited the completion of the GBT, with its combination of large collecting area and full steering capability.

Last fall we began observing several galactic bulge globular clusters at 1400 MHz, using the Berkeley-Caltech Pulsar Machine (BCPM) as our search backend. Our long wait ended most spectacularly: here we report *three* new binary millisecond pulsars in M62 (NGC 6266). The discovery was announced in a recent IAU Circular (Jacoby et al. 2002).

Table 1 lists the preliminary parameters of these new pulsars (D, E, and F) along with the three previously known pulsars in M62 (A, B, and C; D'Amico et al. 2001). M62 now

Name	P (ms)	P_B (d)	a sin (i) (lt sec)	M_2 *min* ($M_\odot$)
PSR J1701-3006A	5.241	3.80	3.48	0.19
PSR J1701-3006B	3.593	0.14	0.25	0.12
PSR J1701-3006C	3.806	0.21	0.19	0.07
PSR J1701-3006D	3.418	1.12	0.98	0.12
PSR J1701-3006E	3.234	0.16	0.07	0.03
PSR J1701-3006F	2.295	0.2	0.05	0.02

Table 1. Approximate parameters of known pulsars in M62.

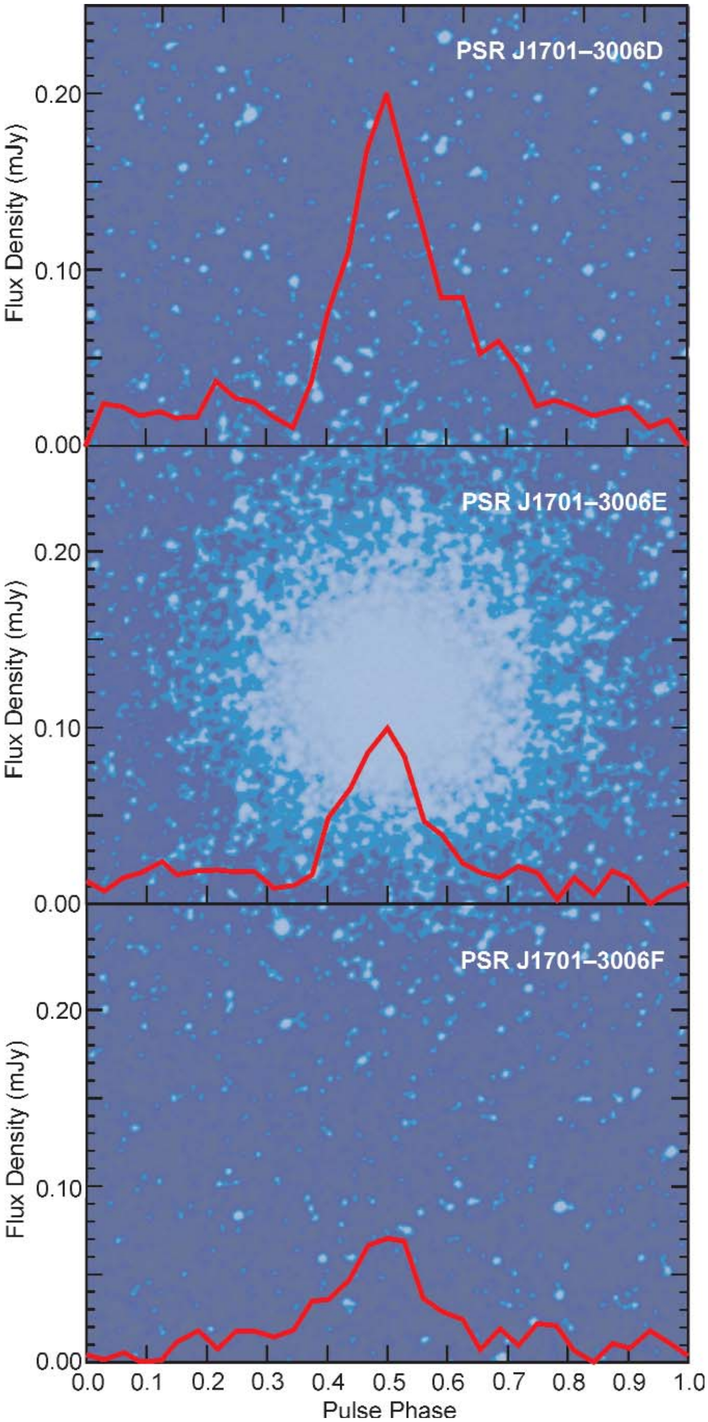

Figure 1. Preliminary pulse-profiles for the new binary millisecond pulsars overlaid on an optical image of M62 (courtesy of the Second Digital Sky Survey, copyright (c) 1993-8 by AAO and AURA).

ranks third in number of known pulsars among globular clusters, only M15 and 47 Tuc have more with 8 and 20 respectively (Anderson 1993; Camilo et al. 2000).

Finding binary pulsars with orbital periods comparable to the observation length is challenging; these three new pulsars were found through painstaking inspection of power spectra. This preliminary analysis step will be followed by a more automated acceleration search.

We plan to begin systematic timing observations for these three new pulsars and other pulsars subsequently discovered in our GBT survey. Timing observations will allow the precise determination of pulsar positions, as well as spin and Keplerian orbital parameters. This information can be used to probe the structure of the globular cluster, using the pulsars as accelerometers in the cluster's gravitational potential. Also, the pulsar populations in M62, M15, and 47 Tuc appear to be distinctly different; we hope that expanding the sample of clusters with a large number of known pulsars will lead to a better understanding of pulsar formation and evolution in globular clusters.

It is gratifying to make the first pulsar discoveries with the GBT, especially with our own instrument. This has been an especially rewarding project for graduate students Jacoby and Chandler. We would like to thank the Green Bank staff for their help and support.

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The AGN Content of the Boötes Field of the NDWFS

The NOAO Deep Wide-Field Survey (NDWFS) is an imaging survey of two 9-square-degree fields with 5σ detection thresholds in the optical (B_wRI) of 26 AB magnitudes and in the near-infrared (JHK) of 21 AB magnitudes (Jannuzi & Dey 1999). The NDWFS data products will, ultimately, provide photometric and astrometric data on millions of discrete sources. Which of these discrete sources harbor active galactic nuclei (AGN)? A complete census demands a multiwavelength approach. We have begun an AGN inventory of the Boötes field of the NDWFS, based on the flux density and compactness of the radio continuum emission as measured by the brightness temperature. Specifically, the NRAO Very Long Baseline Array (VLBA) can be used to apply a brightness temperature filter for AGN, employing the empirical finding that sources with brightness temperatures above 100,000 K are too compact to be starbursts and must therefore be driven by AGN (Condon 1992).

The VLBA was used in April 2001 at 5.0 GHz to image 27 of 100 FIRST (Faint Images of the Radio Sky at Twenty-Centimeters survey) sources in the Boötes field of the NDWFS (Figure 1). The FIRST sources were selected as being compact and bright enough to have typical position errors in one dimension of ±400 mas at 4σ (Becker, White, & Helfand 1995; White et al. 1997). For each FIRST source, this a priori position error defines the VLBA search region in a phase-referenced image with a FWHM resolution of 3.3 mas by 1.5 mas with a P.A. ~ -7°. FIRST images of these 27 sources imply that 24 are candidates for containing AGN, two are hotspots within a single extended source, and one is a jet-like feature adjacent to an AGN candidate. Among the 24 FIRST sources that are AGN candidates, five were detected with the VLBA above a typical 6σ threshold of 1.5 mJy/beam and with a position error in one dimension of ±1.5 mas (1σ, Figure 2). Each VLBA detection has a brightness temperature greater than 10^7 K.

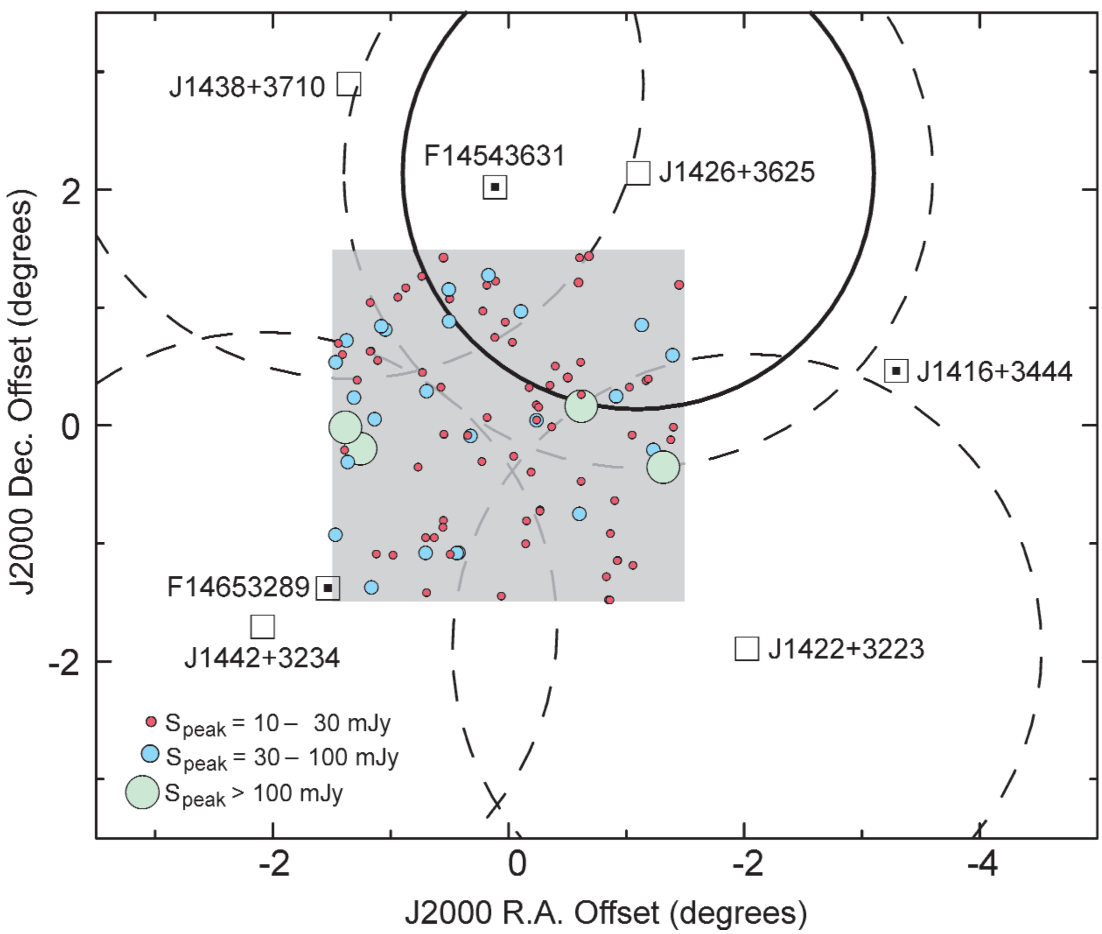

Figure 1. Grey square is three degrees on a side and shows the Boötes field of the NDWFS. The colored circles in the field show 100 FIRST sources, with bigger circles encoding stronger sources. The calibrators outside the field are marked as simple squares for phase calibrators and as squares with inner symbols for astrometric check sources. The two check sources closest to the survey region are weak CLASS sources. A dashed circle of radius 2.5 degrees is centered on each phase calibrator, showing a plausible switching angle for phase referencing at a frequency of 5.0 GHz. Each FIRST source in the field is therefore accessible to the VLBA. We report VLBA results for the 27 FIRST sources located two degrees (thick circle) or less from the phase calibrator J1426+3625.

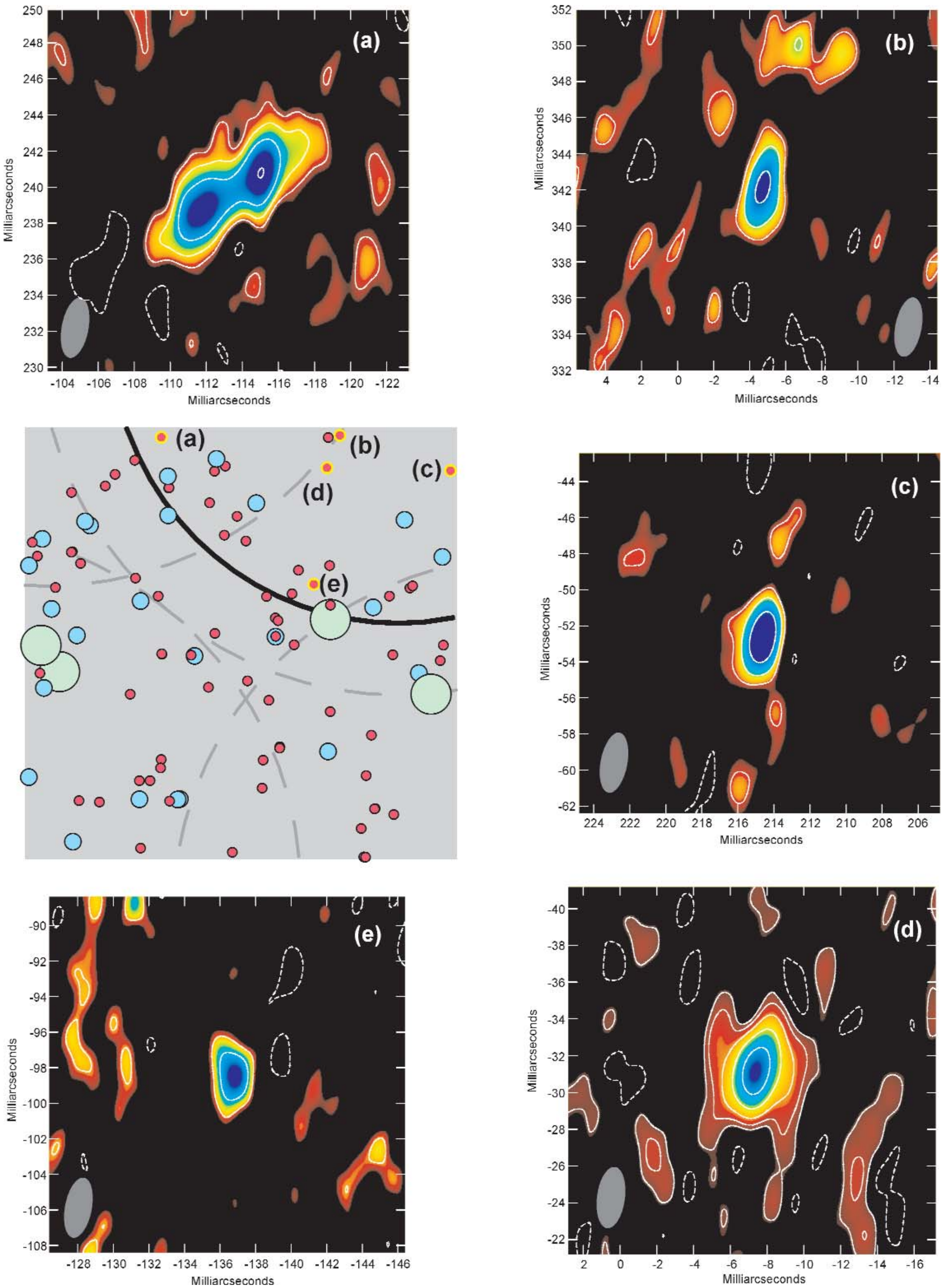

Figure 2. Montage of VLBA images of Stokes I emission from five FIRST sources detected at a frequency of 5.0 GHz. Each cleaned image is centered on the position of the VLBA detection and spans 20 mas. In each image, the grey ellipse shows the Gaussian restoring beam at FWHM; negative contours are dashed while positive ones are solid; the color scale shows positive intensities with red starting at ~0.3 mJy/beam and blue at the image peaks of 4.1, 2.2, 3.2, 14.8, and 1.7 mJy/beam in panels (a)-(e), respectively; and contour levels are at -4 (absent), -2, 2, 4, 8, and 16 times the rms noise level. Panel (d) has an extra contour level at 32.

The five VLBA detections are too compact to be starbursts and must, therefore, be driven by AGN. Optical images from NDWFS data release 1.0 suggest that two of these AGN are hosted by galaxies with photometric redshifts beyond 1, while two are probable quasars. NDWFS images are not yet available for the fifth AGN, a possible compact symmetric object. While an unusually powerful radio supernova in a nearby galactic nucleus could mimic an AGN for a few months or years (Wrobel, Fassnacht, & Ho 2001), such a supernova would remain undetected at the cosmological distances of these five sources. The VLBA astrometry of these five AGN anchors the Boötes field to the International Celestial Reference Frame (Ma et al. 1998). The 19 AGN candidates not detected with the VLBA could still harbor AGN weaker than 1.5 mJy/beam at 5.0 GHz. Therefore, the AGN content in the radio regime of the Boötes field is at least 21 ± 9%. The statistical accuracy of this result is set by the small numbers of AGN candidates observed and detected in this pilot VLBA survey.

When complete, the VLBA survey of the Boötes field will target about four times as many AGN candidates. This will improve measures of the AGN content and enable meaningful comparisons with the predictions of evolutionary models for radio source populations, such as the promising one based on a unification scheme (Jackson & Wall 1999). More VLBA detections will also help broaden knowledge of the range of structures in samples unbiased by spectral preselection. This could lead to the discovery of new types of VLBA sources and also have implications for the interpretation of VLBA images of sources thought to be gravitationally lensed (Augusto et al. 2001). Further VLBA non-detections of AGN candidates will still have astrophysical value, because of the visibility-function constraints on mas scales and the ancillary identification information. Analysis of these topics for all undetected AGN candidates will be deferred until the VLBA survey is complete.

Finally, we note that the strategies developed for this pilot VLBA survey of the Boötes field (Wrobel et al. 2001) can be applied to any region of the North Galactic Cap covered by the FIRST survey, with ancillary photometric and spectroscopic data drawn from the Sloan Digital Sky Survey (York et al. 2000). Tens of thousands of FIRST sources can therefore be filtered for AGN with the VLBA, opening a new era in the study of radio source populations at milliarcsecond resolution.

Acknowledgments: This work used images provided by the NDWFS (Jannuzi & Dey 1999), which is supported by NOAO. The NOAO is operated by AURA, Inc., under a cooperative agreement with the NSF.

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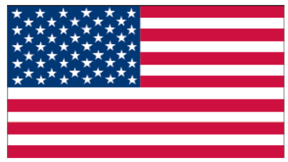

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