NRAO Newsletter

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

January 2003 | www.nrao.edu/news/newsletters | Number 94

ALMA

This fall has been a busy period as construction activities accelerate for the ALMA project. The most visible evidence of progress is the completion of the first prototype antenna at the ALMA Test Facility (ATF) located at the VLA site. The VertexRSI antenna erection has been completed and the antenna is undergoing a period of extensive tests to verify its performance. A second antenna, supplied by our European partners, will be erected at the ATF next year. The European antenna, produced by a consortium led by the French company Alcatel, is scheduled to be available for tests beginning in June 2003. Construction of the foundation for this antenna is already underway.

The ALMA Coordinating Committee (ACC) met with the Japanese at ESO headquarters in Germany to begin negotiations for the possible entry of Japan into the ALMA project. The Japanese are hopeful they will receive funding in 2004. The ACC formed a team to carry out the formal negotiations and tasked the Joint ALMA Office (JAO) with technical liaison with the National Astronomical Observatory of Japan (NAOJ). The Japanese are preparing a detailed proposal to bring significant enhancements to the baseline ALMA. These enhancements may include a compact array of seven- and twelve-meter antennas to improve imaging with short baselines, additional frequency bands, and a second generation correlator. Choices of enhancements will depend on the level of Japanese funds available. The ALMA Science Advisory Committee (ASAC) has provided the ACC with the science cases and a priority ranking of potential ALMA enhancements. In anticipation of their entry, the Japanese will bring a prototype antenna to the ATF in 2003 for tests to verify its suitability for use in the compact array.

The VertexRSI prototype antenna construction has been completed.

NRAO Director Fred Lo has convened a panel of experts from inside NRAO to review the technical details of those portions of the ALMA project assigned to North America. Darrel Emerson chairs the ALMA Technical Advisory Committee (ATAC). Other members of the committee are Barry Clark, Larry D'Addario, John Payne, Peter Napier, Dick Sramek, Dick Thompson, and Lee King. The ATAC is currently reviewing existing documentation and conducting interviews with key members of the ALMA North American staff. The committee will submit an initial report to the NRAO Director and is expected to continue as a standing committee.

Significant progress has been made preparing for the start of civil infrastructure construction late in calendar year

Index

2003. An architectural firm, M3, has been retained to begin the design of the buildings at the array site. They are currently collecting detailed requirements from the technical Integrated Product Teams (IPTs). In addition, the Science IPT has supplied locations for the foundations of the compact and intermediate configurations. These locations will be surveyed and marked so that the terrain and soil conditions can be checked for suitability, for foundation, and access road construction. Finally, an expert consultant has completed a detailed study examining the various options for supplying electrical power at the array site and the Operations Support Facility (OSF). The recommendations are being reviewed and a choice of options will be made early in 2003.

M. D. Rafal

GREEN BANK

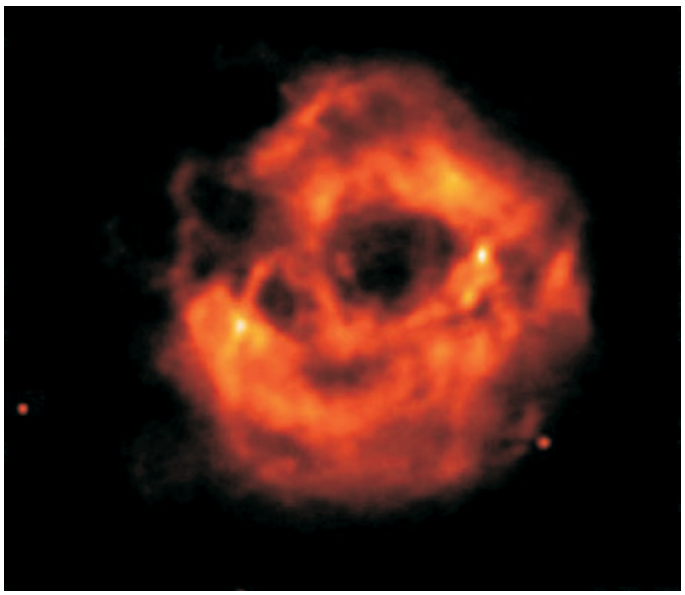
The Green Bank Telescope

The GBT observing capabilities, and the number and variety of observing programs that can be supported, are continuing to expand. Programs scheduled in recent weeks include pulsar observations, VLBI, planetary radar, and an increasing number of Galactic and extragalactic spectroscopy projects. For the past several months, about 30 percent of total telescope time has been scheduled for refereed observing programs. This fraction will stay at approximately the same level during the winter months as we develop observing capabilities in the 1.3 cm (K) band, and should grow substantially in the late spring as these and other systems are completed.

The GBT commissioning activities over the past few months have centered on Spectrometer development and checkouts, system robustness and reliability, and general ease of use. The GBT Spectrometer has more than 200 possible auto-correlation and cross-correlation modes. Most of these modes have undergone initial engineering checkouts. About 17 of these modes will satisfy the majority of observing proposals presently in the queue, and commissioning efforts have centered on astronomical checkouts of these. Many proposals request multi-bank operation of the Spectrometer, in which up to eight input IFs and all digital sections are active. This capability became available in the November release of the Monitor and Control System and astronomical verification is underway. We anticipate that all of the priority auto-correlation modes will be verified within the next two months.

The Software Development group has made significant improvements to the reliability of the local oscillator control and Spectrometer systems. Overall robustness has been improved and a number of specific problems fixed in these areas. A new observer's configuration tool is under development that will allow the GBT to be configured and observations executed much more easily. An initial version allowing simple selection of Spectrometer modes was released for use in the autumn.

On November 12, an Observatory-wide internal review of the GBT commissioning and development program was held. Scientists and engineers from all NRAO sites participated in person or by video connection. The goals of the review were to inform the participants of the status of GBT commissioning and development, solicit advice on priorities, and present opportunities for scientists from around the Observatory to contribute to GBT activities. The review appears to have accomplished all these goals. A number of decisions on priorities were reached during the review. In the commissioning areas, improvements in spectral baseline flatness over wide bandwidths were deemed most important. In the project development area, work on the Precision Telescope Control System that will allow efficient operation of the GBT at 3 mm wavelength was top priority. In the



8 GHz continuum image of the Rosette Nebula using the GBT (Ghigo and Maddalena).

antenna engineering and operations area, work on the GBT azimuth track was seen as most important. These projects will have first call on engineering and scientific staff resources and on telescope use over the next few months.

On October 31 and November 1, a review panel met in Green Bank to consider the engineering issues of the GBT azimuth track described in the October 1 *NRAO Newsletter*. The panel had eleven members drawn from engineering consulting firms, university departments, research institutes, and the NRAO. It was chaired by Karl Frank of the University of Texas. The panel analyzed the history of the azimuth track and a considerable amount of engineering test data provided by the NRAO. To address the problems and consequences of accelerated wear of the track, the panel recommended a three-step process consisting of: 1) further analysis of the wheel support assembly and the track splice joints; 2) retrofits of the existing track in an effort to stiffen the joint areas and remedy the wear problems; and 3) development of concepts for a new track design, should that eventually be required. The Observatory is presently evaluating the panel's conclusions, but anticipates a vigorous plan of action based on their recommendations.

P. R. Jewell

Limited call for GBT Proposals Deadline: February 3, 2003

The next deadline for observing proposals for the GBT will be February 3, 2003. We presently have about 4000 hours of proposals in the queue from previous calls, and are discharging these only gradually. During the winter months, a large fraction of available telescope time will go to K-band, Q-band, and Spectrometer commissioning. To avoid an excessive buildup in the queue, while allowing access for priority and time-critical projects, this call will be limited to ~400 hours of observing time. Given the limited time available, the Scheduling Committee will give some preference to meritorious programs that are time critical, such as target of opportunity proposals and those needed for Ph.D. programs. The proposals otherwise will be rank-ordered and selected until the available time is exhausted. Proposals will be accepted for all standard observing modes at frequencies through 50 GHz.

Available observing modes include spectral line, continuum, pulsar, and VLBI/VLBA. Pulsar modes include those with the Spectral Processor, and the BCPM (Berkeley-Caltech Pulsar Machine) through agreement with its developers. Receivers include 290-920 MHz (PF1), 910-1230 MHz (PF2), 1.15-1.73 GHz (L), 1.73-2.60 (S), 3.95-5.85 (C), 8.0-10.1 (X), 12.0-15.4 (Ku), 18.0-26.5 (K), and 40-50 GHz (Q). Proposals requesting GBT participation

The Robert C. Byrd Green Bank Telescope

in VLBA or global VLBI observations should be submitted to the VLBA only, not to the GBT. As this scheduling period is for the late spring and summer months, programs at frequencies of K-band and above will be deferred until at least next autumn, with the possible exception of target of opportunity requests.

We can occasionally support observing requests for background survey projects done in a drift-scan mode, while the telescope is parked for maintenance. Proposals for such projects can be submitted for the February 3 deadline. These proposals should be for frequencies below ~1.7 GHz (L-band and below), for projects such as pulsar, HI, OH, or continuum surveys. The project must be amenable to arbitrary, but indicated, telescope position. The projects will be scheduled strictly on a time-available basis, and there is no guarantee of total time available. The programs will be active for a maximum of 12 months from the deadline.

All proposals must be submitted electronically using version 1.1 of the NRAO Proposal Submission Tool (PST), which is available from the downloads page. If you have downloaded v1.1 previously, you need to download a new version of the gbtDatan.xml file, which informs the PST of available resources, start and end dates, etc., for each semester. This is a simple text file, which needs to be copied to the appropriate source location for the PST to access.

Proposal receipt will open on Monday, January 6, 2003, and will close at 5 PM EST on Monday, February 3, 2003.

Questions about the proposal submission process may be addressed to Carl Bignell (304-456-2165). Technical questions about GBT hardware, software, and observing modes may be addressed to Ron Maddalena (304-456-2207).

Phil Jewell

Astronomy Education and Visitor Center Update

The Astronomy Education and Visitors Center (AEVC) construction is moving along very nicely. Although weather has caused a delay in the completion date of the project until the end of January, the construction has been proceeding with an eye toward quality and performance. The building exterior is essentially finished and windows and doors are installed. The contractor has completed most interior work and has been concentrating on finishes and shielding issues. The shielded computer lab has been RF tested and passed the requirements of the specifications by better than 13 dB of attenuation. The exhibit hall is also shielded, and will be tested soon.

As part of this project, a new dormitory for students will be constructed across the parking lot from the existing Residence Hall in Green Bank. This dorm will house about 70 students total in bunkhouse-style rooms, and will support the education activities of the AEVC. The contract for this part of the project has been signed and the “Notice to Proceed” has been given to the contractor. Some work has begun, but weather will determine how much work gets accomplished through the winter months. By summer 2003, Green Bank should be well equipped to support a new and expanded education and tour program.

M. J. Holstine

The Astronomy Education and Visitor Center (AEVC) construction is moving along nicely.

SOCORRO

Impact of EVLA Construction on Observers

During the entire VLA Expansion Project we are committed to keeping the VLA observing and producing forefront science. It is expected, however, that there will be some periods when the amount of observing time is reduced, and the average number of antennas available may be fewer than for the nominal VLA. To keep people informed of the impact of the EVLA construction on VLA observations we have created a web site at *http://www.aoc.nrao.edu/evla/archive/transition/impact.html*. At the web site are short, medium, and long term forecasts. Below is the medium term forecast as of this writing in December 2002.

Medium Term Forecast (year 2003): Antenna 13 has been designated as the EVLA prototype antenna. In mid-April 2003 we expect antenna 13 to be moved to the Antenna Assembly Building as part of the regular overhaul schedule. Instead of the regular overhaul, however, Antenna 13 will be outfitted as an EVLA Antenna, with the new monitor and control system, fiber IF transmission, etc. In late June of 2003, Antenna 13 is expected to move to the master pad for further testing. At this time, the VLA effectively will be reduced by one antenna. A gap will be introduced in the middle of the west arm so that the VLA will retain the full resolution expected in each configuration. The VLA call-out rules will change to four antennas, i.e., on nights and weekends nobody will be called out to the VLA to attempt repairs until more than four antennas are out of the array (including Antenna 13), thus guaranteeing usable data from a minimum of 23 antennas. The VLA currently operates with fewer than 26 antennas for only a few percent of the time, so we hope to be operating with 25 or 26 antennas much of the time in mid to late 2003. In late August of 2003, Antenna 13 will be moved to the EVLA test pad at pad W10 where it will undergo further testing. Antenna 13 will be unusable for science until the transition mode of operations is verified in 2004 and Antenna 13 can rejoin the VLA. Also, Antenna 13 will remain at W10 to allow easier access for the project, so it will not participate in normal VLA reconfigurations. During the C configuration in late 2003, Antenna 13 will displace the antenna normally at CW5=W10.

G. B. Taylor , J. S. Ulvestad

Azimuth Bearing Change

The azimuth bearing on Antenna 7 was successfully replaced during the week of September 16, 2002. The replacement of this 10-foot diameter bearing was the sixth bearing change undertaken by the Engineering Services Division at the VLA site. The bearings had to be replaced because metal flakes were found in the bearing grease, indicating excessive wear on the bearings. This wear is attributed to normal operations over the 20-plus year service life of the bearing and, possibly, inadequate lubrication of the bearing when it was originally installed. A recent survey indicates that at least five more antennas need their azimuth bearings replaced.

The replacement of an azimuth bearing is a carefully choreographed procedure that basically involves splitting the 230-ton antenna in two large pieces. A transporter positions the antenna over a special support structure in the antenna assembly building, and carefully lowers the antenna onto the structure. To ensure that the four steel beams in the support structure carry their fair share of the antenna load, antenna mechanics position metal shims between the beams and yoke arms of the antenna, and the transporter operator adjusts the load on each beam using real-time strain measurements from strain gauges on the beams. Once the load of the antenna is completely carried by the structure, the bolts that secure the bearing to the upper, rotating portion of the antenna are removed, separating it from the antenna pedestal below. The pedestal, which contains the azimuth bearing, is completely separated from the upper portion of the antenna by simply lowering the pedestal with the transporter. While the structure supports the upper portion of the antenna, the transporter moves the pedestal from beneath the structure to the location of a 5-ton overhead crane where the azimuth bearing is actually removed from the pedestal. A large mill designed and built by Engineering Services Division personnel can be used to smooth the interior surface of the bearing housing cavity in the pedestal if any imperfections are found. The new bearing is installed in the pedestal after the housing has been thoroughly cleaned. The reassembly of the entire antenna completes the bearing change.

M. M. McKinnon, J. E. Thunborg

Bearing change on Antenna 7 was successfully replaced during the week of September 16, 2002.

VLA Configuration Schedule; VLA / VLBA Proposals

Configuration	Starting Date	Ending Date	Proposal Deadline
DnC	17 Jan 2003	03 Feb 2003	1 Oct 2002
D	07 Feb 2003	12 May 2003	1 Oct 2002
A(+PT)	30 May 2003	08 Sep 2003	3 Feb 2003
BnA	19 Sep 2003	06 Oct 2003	2 Jun 2003
B	10 Oct 2003	05 Jan 2004	2 Jun 2003
CnB	16 Jan 2004	02 Feb 2004	1 Oct 2003
C	06 Feb 2004	10 May 2004	1 Oct 2003

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 mail, as described in the web sites given above. FAX submissions will not be accepted. 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. For VLA proposals, email addresses can be transmitted in the most recent proposal coversheet. For VLBA proposals, email addresses can either be included in the proposal itself or else emailed separately to *lappel@nrao.edu*.

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 2003, the A configuration daytime will involve RAs between 05^h and 12^h. EVLA construction will begin to impact VLA observers in 2003; please see the separate article by Greg Taylor and Jim Ulvestad, plus the related web page at *http://www.aoc.nrao.edu/evla/archive/transition/impact.html.* Note that current and past VLA schedules may be found at *http://www.aoc.nrao.edu/vla/schedules/this_dir.html.*

	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

Approximate VLA Configuration Schedule

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. 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.aoc.nrao.edu/vlba/schedules/this_dir.html* 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. 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, J. M. Wrobel
schedsoc@nrao.edu

Disc-Based Recording System for the VLBA (and NMA)

The VLBA's data acquisition system is based on recording technology dating to the 1970s and earlier, although several innovations, unique to VLBI, were developed in the 1980s. The VLBA's sustained throughput is limited to 128 Mbps, while all other parts of the system could sustain operation at eight times that rate for a 10-station array. Several consumable or failure-prone parts are available only from single suppliers, which threatens the operational viability of the VLBA.

The need for a replacement recording system, capable of wider-band and more reliable operation, led NRAO to join other organizations in supporting the "Mark 5" development project launched by Haystack Observatory in January 2001. Mark 5, based on large-capacity magnetic disc drives, is described at *http://web.haystack.mit.edu/mark5/Mark5.htm*. As part of the current, final development phase, three prototype Mark 5 recording units were received recently at the AOC, and used to demonstrate successful recording and correlation in test observations.

We are exploring funding options to equip the ten VLBA stations, the VLA, the GBT, and the VLBA correlator with disc-based recording systems, and to procure the necessary pool of disc drives. The latter requirement dominates the expected cost of about $3 million.

In the longer term, disc-based recording is a potential solution for combining the VLBA with the New Mexico Array antennas planned for phase 2 of the EVLA. Signals sampled at 1 GHz RF bandwidth (4 Gbps) or 4 GHz (16 Gbps) could be interfaced expeditiously to the EVLA correlator being designed by Dominion Radio Astrophysical Observatory in Penticton, British Columbia, Canada. The Mark 5 system also can serve as an interface to wide-area data networks, to facilitate real-time or near-real-time VLBI observing when and if "e-VLBI" becomes cost-competitive.

J. D. Romney, W. F. Brisken, R. C. Walker

VLBA Data Calibration Pipeline

The first version of the VLBA Data Calibration Pipeline is being included in the AIPS distribution of 31DEC02. Although some anticipated features, such as polarization calibration, are not yet incorporated, this version of the VLBA Data Calibration Pipeline provides fully automated calibration of most VLBA-only experiments. These include low and high frequency observations, with and without phase-referencing. A full description of the current status and limitations of the VLBA Data Calibration Pipeline can at all times be obtained from the VLBA astronomer web page (*http://www.aoc.nrao.edu/vlba/html/vlbahome/observer.html*) under "Calibration and Imaging." This page will describe new features and the VLBA Data Calibration Pipeline will be updated through the AIPS MidNight Job in the 31DEC03 version.

Service calibration of many user experiments with the pipeline has been available since June 2002. To request your calibrated data from recent experiments, or to ask questions about the pipeline send inquiries to the undersigned, at *lsjouwer@nrao.edu*.

L. O. Sjouwerman

Joint Chandra Proposal Process with VLA/VLBA

We have implemented an experimental joint proposal process with the Chandra X-ray Center for the Chandra Cycle 5 Call for Proposals, with proposals due on March 14. Up to 3 percent of time on the VLA and the VLBA during Chandra Cycle 5 may be allocated by means of a single proposal asking for both X-ray and radio observations, and submitted to the Chandra X-ray Center. No proposal will be accepted for this time allocation unless the scientific reviewers determine that both Chandra and VLA/VLBA datasets are required in order to meet the scientific goals of highly ranked proposals. NRAO will provide technical reviews of the radio parts of the proposals, and will suggest possible "radio-knowledgable" members for the relevant Chandra scientific review panels. Further details about the Chandra proposal process can be found in the Cycle 5 Call for Proposals, available on the Chandra X-ray Center web site at *http://cxc.harvard.edu/*. For specific questions about VLA/VLBA aspects of this joint proposal process, please contact Joan Wrobel at *jwrobel@nrao.edu*.

J. S. Ulvestad

VLA/VLBA Large Proposals

A number of "large" VLA proposals have been accepted over the last several years, and additional VLA and VLBA large proposals are currently in the Skeptical Review process. The working definition of large proposals is that they involve requests for at least 300 hours of observing time in a single proposal. One of the requirements of accepted large proposals is that they make data products publicly available in return for the large amount of observing time requested and awarded. In order to facilitate access to these data products, we have created a new VLA/VLBA Large Proposal web site that contains links to the project descriptions and data products maintained by the proposers, as well as a description of the large proposal policy and a list of upcoming deadlines. The new web site can be found at *http://www.aoc.nrao.edu/vla/html/vlahome/largeprop/*.

In October, a Skeptical Review of the first two large VLBA proposals was conducted; final dispensation of those proposals was determined at the Scheduling Committee meeting in December. At the October 1 deadline, we received six large VLA proposals as well as an additional large VLBA proposal. A Skeptical Review committee meeting will be held in February, with final decisions reached by April. After decisions are made on these proposals, those that have been allocated observing time will be added to the web site listed above.

J. S. Ulvestad

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	Bands	Proposals Due
06 Feb to 27 Feb 2003	18/21 cm, 6 cm, 1 cm ...	01 Oct 2002
22 May to 12 Jun 2003	18/21 cm, 6 cm, 5 cm ...	03 Feb 2003
23 Oct to 13 Nov 2003	18/21 cm, 6 cm ...	02 Jun 2003

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 JIVE correlator that 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 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 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 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, either by including them in the proposal itself or by emailing them separately to *lappel@nrao.edu*.

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

NRAO-NM Computing Division

As announced in the previous *NRAO Newsletter*, we are in the process of replacing our remaining two public Sparc stations with much faster dual-processor PCs running the Linux operating system. We had been keeping the two fastest Sun workstations for visitors requiring the Solaris operating system, but demand for these machines has been essentially non-existent. One of the new PCs is already in place; the second one will be installed shortly.

Over the next two years the AOC will be converting from twisted pair ethernet cable to fiber optic cable. The majority of the existing twisted pair cable is only capable of 10 Mbit/sec data rates. The majority of the new fiber will run at a 1 Gbit/sec data rate and is capable of 10 Gbit/sec. The conversion involves pulling 1/4" tubing from central communications closets to individual office jacks. Once tubing is in place the fiber is blown through the tubing with compressed nitrogen. The air-blown fiber system will simplify access to more difficult portions of the building as well as allowing us to convert offices on a case by case basis. Core switches and servers should be converted by the beginning of 2003. Public systems and computational systems which need access to the new VLA/VLBA on-line archive or other centralized storage will be converted early in 2003. The remaining systems will be converted as we go.

G. A. van Moorsel

The NRAO Hosts the 18th Annual New Mexico Symposium

Dark skies and remote sites have attracted world-class astronomical facilities to the Southwest and supported a wide range of research since the mid-1900s. The achievements span areas in both science and technology, including optical and radio interferometry, and research in solar physics, planetary science, star and galaxy formation, and the creation and evolution of our universe. To support the network of scientific research in the Southwest and encourage interdisciplinary discussions, the NRAO sponsored the 18th Annual New Mexico Symposium on Friday, November 1, 2002, at the NRAO Array Operations Center in Socorro. The symposium was a huge success, filling the auditorium to full capacity. More than 120 astronomers, astrophysicists, and engineers from 13 institutions in New Mexico, Colorado, and California attended the symposium. Invited speakers were:

Prof. Shri Kulkarni, California Institute of Technology
Space Interferometry Mission: Planets and More

Prof. Jim Murphy, New Mexico State University
Water on Mars: Lowell's Revenge?

Dr. Bill Priedhorsky, Los Alamos National Laboratory
A New Look at Our Partner Galaxy (M31/Andromeda) in the X-ray Band

Dr. Chris Carilli, National Radio Astronomy Observatory
Studying the Neutral Intergalactic Medium Prior to the Epoch of Reionization

Sixteen shorter talks and 30 posters also were presented on a range of topics, including: *Multi-wavelength Observations of Herbig Ae/Be Stars*, *Astrobiology: Bacterial Survivability in Collisional Events*, *Radio Relics in Galaxy Clusters*, *Monitoring RFI in New Mexico*, *The Summer Science Program Opens on the New Mexico Campus*, and

The Challenge of Public Outreach...at Radio Wavelengths. Prof. Shri Kulkarni ended the symposium with a bang and presented the 2002 annual Jansky Lecture entitled *The Brightest Explosions in the Universe*.

D. S. Shepherd

Program for University Classes

Instructors of university classes in observational astronomy are reminded that they may request small amounts of observing time on the VLA or VLBA, for use as part of their curriculum. Program details are as published in NRAO Newsletter 87, with the update that requests for time should now be directed to *schedsoc@nrao.edu*.

B.G. Clark, J. M. Wrobel

IN GENERAL

Data Management: Computing Security

Despite the use of anti-virus software on our desktop Windows computers, the NRAO has still experienced a number of cases where a virus was activated, usually from an email message, and caused damage to that computer. For the past few months, the NRAO has been testing centralized anti-virus protection in the form of email gateway systems. These systems are now in operation at our main offices in Charlottesville, Green Bank, Socorro, and Tucson. Please note that all incoming electronic mail is scanned for viral content. If a virus is detected, it is removed from the message and the intended recipient receives notification. All of our outgoing messages will be checked in this way as well, to help ensure that the NRAO does not propagate viruses to other institutions.

M. R. Milner

NRAO Website Redesign

The NRAO's main website [www.nrao.edu], which serves the needs of astronomers, the public, educators and students, as well as NRAO staff, will soon have a new look and features.

Since the internet has become a primary source of information gathering for much of the astronomical community and the world at large, the NRAO is taking a careful look at how it organizes its website and how it presents that information to its customers. The goal is to make the website more dynamic in appearance, with improved navigation tools, and more user friendly.

The first leg in this redesign is the deployment of a new homepage, the initial gateway into NRAO's website, and a number of specialized second-level pages. This redesign will feature new navigation tools, and will have special links for several categories of users. The general public, telescope users, and astronomers, among others, will be able to access the website through specially tailored sections that will contain specific information as well as general navigation tools.

The team of NRAO staff members (scientific staff, computing division, and education and public outreach) who worked on the redesigned Image Gallery has been spearheading this effort. Following a beta review scheduled for the end of 2002, the new homepage should be deployed some time in January 2003. Throughout the course of this effort, there has been an ongoing feedback mechanism from the site directors and site web managers.

This initial redesign is the first step in what will be a more comprehensive consolidation and reworking of the NRAO website and on-line features. This more in-depth overhaul of the website will be carefully planned with input from across the NRAO and take place over the next several months, through the end of 2003.

C. E. Blue

2003 NRAO Summer Student Research Programs

The NRAO Summer Student Research Assistantship program solicits applications for its 2003 Program. Information on the program may be found at: *http://www.nrao.edu/eduction/students/*. As an example of the type of research that students and their advisers undertake at the four NRAO sites, we give a short summary of the research accomplished by the students during 2002 at *http://www.nrao.edu/education/students/NRAOstudents_projects02.shtml*

NRAO Research Experiences for Undergraduates (REU) Program

Information and application forms will soon be mailed soliciting applications for the NRAO Research Experiences for Undergraduates (REU) Program next summer. This program is for undergraduates who are U.S. citizens enrolled at a U.S. undergraduate institution. It is funded by the National Science Foundation's (NSF) Research Experiences for Undergraduates (REU) program (AST division). Students spend 10-12 weeks over the summer working closely with an NRAO mentor on a research project. Students with a background in Astronomy, Physics, Engineering, Computer Science, and/or Math are preferred. Go to *http://www.nrao.edu/education/students/summer-students.shtml* for an application and a more detailed job description. Site specific information and links to previously conducted research projects are available at the NRAO Summer Student web site at: *http://www.nrao.edu/education/students/NRAOstudents_summer.shtml*.

The deadline for receipt of application materials will be January 24, 2003; notice of decisions will be sent by March 1, 2003. Forms are available from department heads, on the web at: *http://www.nrao.edu/education/students/summer-students.shtml*. Web-based applications will be available for the first time this year. Information may also be obtained by writing to:

National Radio Astronomy Observatory
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Charlottesville, VA 22903-2475

NRAO Graduate Summer Research Program

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H. A. Wootten

NEW RESULTS

VLA and Spacecraft Imaging of Nonthermal Energy Release in the Solar Corona

During the past decade, spacecraft observations of the Sun have provided new insights into the nature of the Sun's extensive, million-degree outer atmosphere: the solar corona. High angular resolution soft X-ray and Extreme Ultraviolet (EUV) images obtained by the Japanese Yohkoh satellite, the Solar and Heliospheric Observatory (SOHO), and the Transition Region and Coronal Explorer (TRACE) have been used to study the physical characteristics of solar active regions as well as powerful solar flares and related phenomena known as coronal mass ejections (CMEs). These observations are contributing to a better understanding of several outstanding problems in solar physics including the processes that sustain the hot corona and give rise to flares and CMEs.

Very Large Array (VLA) observations of the Sun provide complementary information about the energetic particles that are produced during eruptive solar events. At centimeter wavelengths, for example, the nonthermal electrons accelerated during flares produce gyrosynchrotron radiation as they spiral along the curved magnetic fields of the flaring region. Some of the energetic particles travel downward along the legs of the magnetic loops, producing hard X-rays, and γ-rays when they penetrate the chromosphere at the loop footpoints (Dulk 1985; Lang & Willson 1999). Detailed analyses of the microwave, X-ray and γ-ray data provide important diagnostics of the plasma parameters (magnetic field strength, electron temperature and electron density) of the emitting regions. At decimetric and metric wavelengths, intense nonthermal radio bursts are detected, including Type III bursts produced by electron beams traveling along open magnetic field lines and slower Type II bursts that are accelerated by shocks (see McLean & Labrum 1985 for a review of metric-wavelength observations of the Sun).

Full disk, high angular resolution VLA observations of the Sun at 20 cm, 91 cm, and 400 cm wavelength are now being used to investigate the properties of solar metric and decimetric bursts with high spatial and temporal resolution (e.g. Willson et al. 1998; Willson 2000, 2002). At 400 cm (74 MHz), for example, the VLA can resolve burst sources with an angular resolution of about 25". Snapshot maps on timescales as short as 1 second allow us to associate the sources of decimetric and metric energy release with transient phenomena detected by SOHO and TRACE at different levels in the solar atmosphere, and to measure time delays between these phenomena.

Coronal mass ejections are eruptions of coronal magnetic fields and plasma from the solar corona into the interplanetary medium (see Wagner 1985 for a review). They are associated with a wide range of phenomena during their initiation and outward passage from the Sun, including flares, prominence eruptions, interplanetary shock waves, energetic particle events and geomagnetic storms. Although their origin is not completely understood, the available evidence suggests that the physical structures of CMEs are related to the reconfiguration of large-scale coronal magnetic fields.

The evolution of the coronal magnetic field may also trigger smaller-scale magnetic reconnection events that are sources of nonthermal electron beams that produce Type III bursts at decimetric and metric wavelengths. The outwardly-traveling electron beams that give rise to Type III bursts excite plasma waves at the monotonically-decreasing local plasma frequency, so measurements of the source positions at different wavelengths provide clues to the electron density and magnetic topology of coronal structures in which the electrons propagate.

Here, we discuss a recent example of collaborative observations of solar activity involving the VLA and the SOHO Large Angle and Spectrometric C2 Coronagraph (LASCO). On February 5, 2000, active region AR8858, located near the northeast limb of the Sun, produced two intense soft X-ray bursts, a GOES M1-class flare (detected by the Geostationary Operational Environmental Satellite-M) starting ~19:21:30 UT, followed by an X1 flare starting at ~19:25:20. Impulsive 91 cm and 400 cm burst emission was observed by the VLA beginning at ~19:25 UT and continued for the next 30 minutes. The X1 burst was also detected in hard X-rays by the Burst and Transient Source Experiment (BATSE) detectors on board the Compton Gamma Ray Observatory (CGRO) and in Figure 1 we show time profiles of the 400 cm and 91 cm bursts in left-hand circular polarization as well as plots of the BATSE hard X-ray emission. The BATSE and VLA 91 cm and 400 cm radio emission show similar features during the impulsive phase of the burst and this suggests that the emission in the three wavebands is produced by a common population of electrons. The low-frequency ($\nu = 0.1$ - 13 MHz) dynamic spectrograph from the WAVES experiment on board NASA's Wind satellite also detected fast-drift interplanetary Type III bursts during the onset of the X1 flare and the VLA 91 cm and 400 cm emission (Figure 2).

LASCO subsequently detected a CME above the northwest limb starting at ~19:54 UT. VLA 3.3 sec snapshot maps (Figure 3) showed that the 400 cm burst sources were located at projected heights of h ~ 0.3 - 1.25 $R_\odot$ above the northwest limb with brightness temperatures as high as $T_b = 2 \times 10^8$ K; the 91 cm burst source is located at a lower height of h ~ 0.1-0.2 $R_\odot$ with a similar brightness temperature. The 91 cm and 400 cm radiation probably denotes the level at which the plasma frequency equals the observed frequencies of 327 MHz and 74 MHz, respectively, corresponding to respective electron densities of $N_e \sim 1.3 \times 10^9$ cm^{-3} and $N_e \sim 0.6 \times 10^8$ cm^{-3}; successive nonthermal bursts appear to form at different radial heights because of the decrease in electron density with increasing distance from the solar surface. The 400 cm bursts appear to be spatially segregated within two distinct groups, namely a southern group that includes bursts between ~19:25 - 19:31:30 UT (denoted by circles in Figure 3) and a northern group, which includes bursts occurring after ~19:31:30 UT (denoted by crosses). The first group of bursts appears to be located along the trajectory of the CME detected by LASCO while the second group lies north of it. The shift in position of these bursts at ~19:31:30 may be due to changes in the extended magnetic field structure of the corona along which the nonthermal particles propagate or perhaps to a change in the structure of the source region responsible for these particles. Examination of the LASCO images indicated that the CME moved outward with a constant velocity of v ~ 765 km s^{-1} so its expected height at 17:25 UT, the start time of the 400 cm burst emission, is h ~ 0.65 $R_\odot$. This height is similar to the height of the 400 cm bursts, suggesting that the nonthermal particles are accelerated in the same magnetic structures as the CME where the CME lifted off and may have played a role in triggering it.

There is great potential for future collaborative studies of nonthermal solar flares and related phenomena using the long-wavelength capability of the VLA. Full-disk radio imaging of the Sun at 20 cm, 91 cm, and 400 cm may be used to provide a global perspective on pre-eruptive and

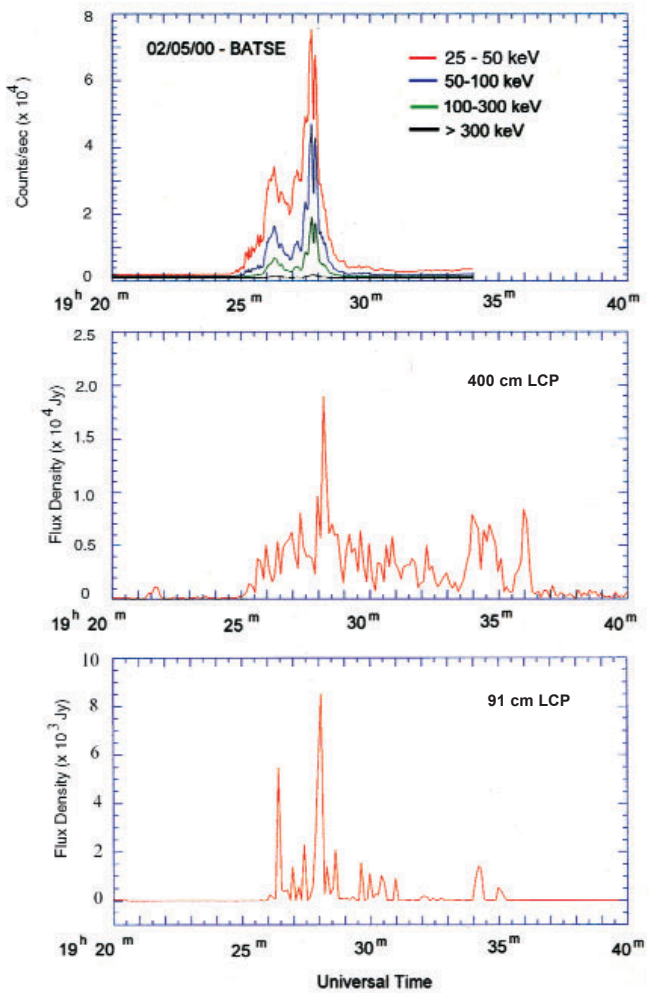

Figure 1. Plots of correlated flux on one VLA baseline in left (LCP) circular polarization showing a group of impulsive bursts at 400 cm (middle) and 91 cm (bottom) wavelength on February 5, 2000. The top panel shows a plot of the hard X-ray burst at different electron energies obtained from BATSE.

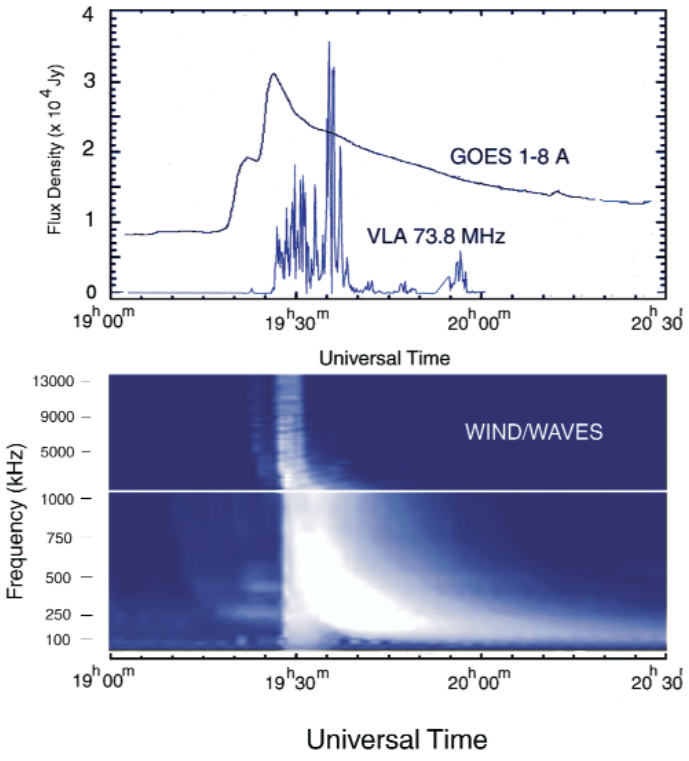

Figure 2. Time profiles of the X1 soft X-ray flare detected by GOES and the associated radio burst observed by the VLA at 400 cm wavelength (top), as well as by the WAVES experiment on board Wind (bottom). The dynamic spectra from WAVES/Wind indicate fast-drift interplanetary Type III radio bursts in this case.

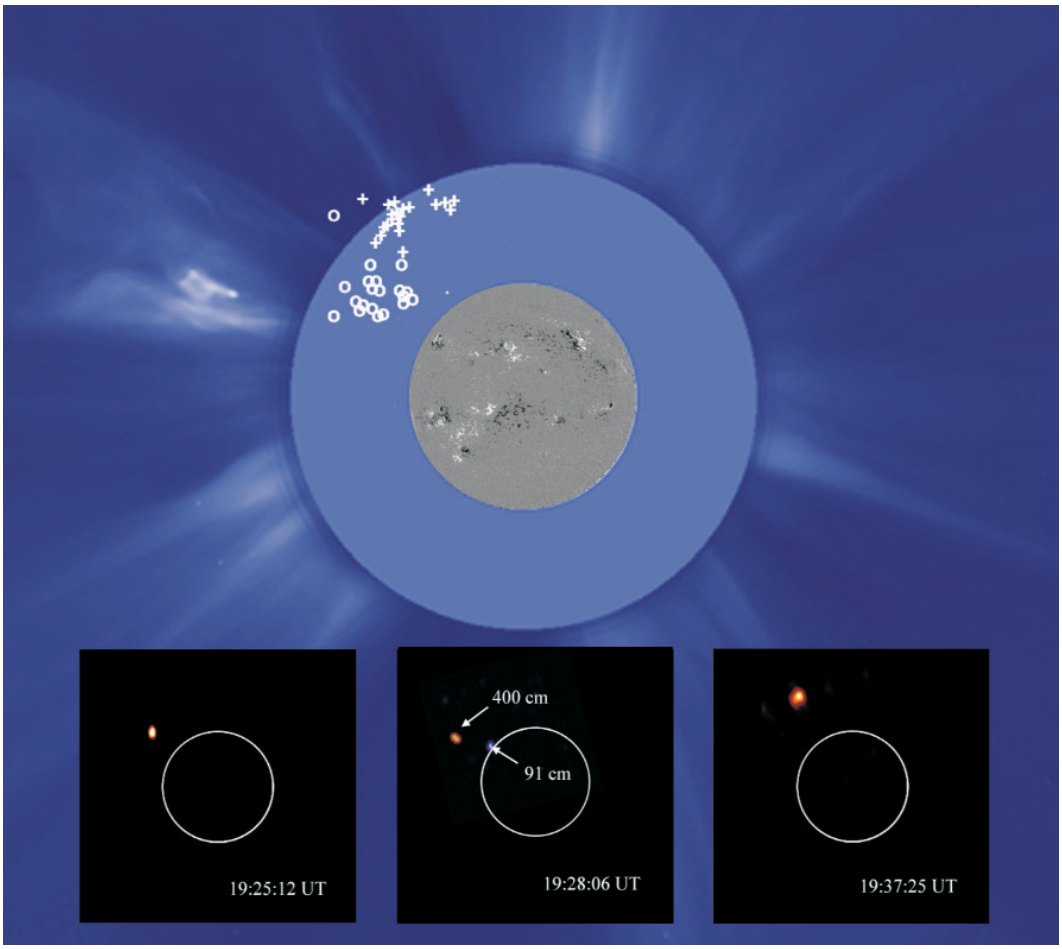

Figure 3. A sequence of VLA snapshot maps at 400 cm wavelength taken at the times indicated on February 5, 2000 (bottom). The middle panel at the bottom also shows the location of the most intense 91 cm burst at 19:28:06 UT. The locations of the most intense 400 cm burst peaks are superposed on a LASCO C2 image taken at 20:25:00 UT. Here, the circles denote bursts which occurred between 19:21:00 UT - 19:31:30 UT and the crosses denote bursts which occurred after 19:31:30 UT. The locations of these two groups of impulsive bursts lie, respectively along and north of the trajectory of a coronal mass ejection seen at a position angle of ~70°. The photospheric magnetogram was taken at 17:18 UT by the Michelson Doppler Imager (MDI) on board SOHO. The arrow denotes the location of active region AR8858 which gave rise to the X flare on this day.

flaring coronal loops at different heights and to enhance our understanding of the physical mechanisms that accompany large-scale eruptive events such as CMEs. There is particular potential for collaborative observations of solar flares involving the VLA and the Reuven Ramaty High Energy Solid State Imager (RHESSI), which was launched on February 5, 2002. The hard X-ray imaging capability of RHESSI (spatial resolution ~2", temporal resolution ~tens of milliseconds) will be used to determine the time profiles and energy spectrum of the emitting electrons and their relationship to the radio structures observed by the VLA at centimeter, decimeter, and meter wavelengths. The combined VLA-RHESSI observations will therefore provide important constraints on models for the acceleration and transport of energetic electrons and ions during solar flares, and will have the unique advantage of high angular resolution images that can be used to directly examine the spatial and temporal association of the different sources.

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A Glimpse into the Funeral Parlor: The Death-throes of a Solar-type Star

Figure 1: Hubble Heritage image of Menzel 3.

Those of us studying the late stages of stellar evolution, especially the circumstellar envelopes around Asymptotic Giant Branch (AGB) stars, have a problem. How can the mass that is seen to be escaping fundamentally spherical objects, stars, be reconfigured into the fantastic and beautiful planetary nebula (PNe) shapes that are seen by the Hubble Space Telescope? Figure 1 shows a fine, though possibly extreme, example of the genre.

Various groups (e.g. Sahai et al., 1999; Alcolea et al., 2001) have seen collimated "jets" and outflows extending up to 0.3 parsec from the central stars of PNe. Precession of these jets has been proposed as a mechanism to produce the observed PNe shapes but, until now, has not been observed. But, how do the jets arise? Blackman et al. (2001) demonstrated that magnetic fields could launch such jets and we know from recent VLBA observations of SiO (Kemball and Diamond, 1998) and H_2O masers (Vlemmings, Diamond and van Langevelde, 2002) that fields of several hundred to a few thousand milliGauss are observed in the circumstellar envelopes of the PNe precursors: Mira variables, supergiant stars, etc. Alternatively, the central, mass-losing star could have a close companion whose influence can result in the formation of outflows.

It is clear that the best way for us to understand the mechanisms involved in this transition phase is to catch an object as it passes through it. The change from AGB-star to PNe is obviously rapid due to the dearth of possible transition objects. However, there are a few candidates. W43A, which lies at a distance of about 2.6 kpc towards Aquila is one possibility.

W43A has always been a maverick. It lies in a confused IR region thus making it difficult to accurately determine the IR spectrum. Single-dish observations of the OH masers showed a typical double-peaked structure characteristic of OH/IR stars (see Figure 2); the central velocity of the spectrum was 34 km s^{-1} and the separation of the two peaks was 16 km s^{-1}. However, the spectrum of the H_2O masers, although having the same central velocity, exhibited a separation of 180 km s^{-1}! MERLIN imaging of the OH and VLA imaging of the H_2O deepened the mystery (Diamond et al.,

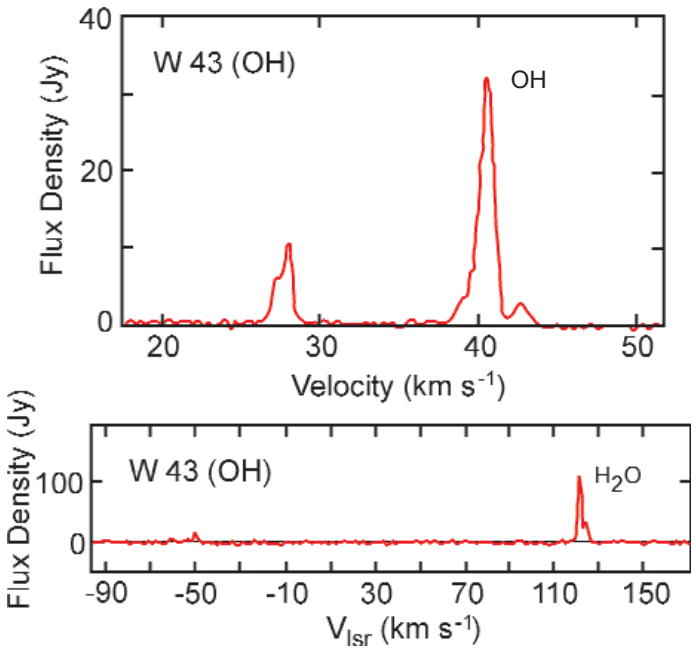

Figure 2. Top panel shows OH spectrum of W43A taken with the Lovell Telescope. Bottom panel shows H_2O spectrum obtained with the Onsala 20-m antenna.

1985; Diamond & Nyman, 1988). The two OH peaks appeared to be concentrated into two complexes: the blue-shifted OH lying about 0.25" to the NE of the red-shifted OH. The H_2O masers were also concentrated into two similar complexes but with a radically different structure: the red-shifted H_2O masers lay about 0.5" NE of the blue-shifted features. After rapid verification of this unexpected structure further investigation was required, since this morphology did not correspond to that expected from an OH/IR star.

However, after 15 years of observation we are finally convinced that we are observing an AGB or post-AGB object. Sensitive observations with the Onsala 20-m, SEST and, more recently, the Nobeyama 45-m telescopes have revealed no evidence for any of the traditional tracers of star-formation regions. Herman & Habing (1985) demonstrated that the OH masers varied with a period of ~400 days, typical of many other OH/IR stars but with a longer period characteristic of more evolved objects. Finally, Nakashima and Deguchi (priv. communication) detected SiO masers with the same central velocity as the other maser species and a modest velocity spread, again a characteristic of an AGB or post-AGB star.

With the advent of the VLBA it was natural to determine the structure of the various masers and also to search for proper motions. Three epochs of data were taken in June and October 1994 and in March 1995. We observed both the OH and H_2O masers in each epoch. The observations are summarized in Figure 3. The OH masers lie in a ring-like structure with a diameter of ~250 milliarcsec and the red/blue separation observed with MERLIN. The data did not have the time baseline to determine proper motions of OH. The H_2O masers lay where we expected from the earlier VLA observations but now the structure was clear. We saw two clusters of masers each about 250 AU (0.1 arcsec) long and 20 AU wide. The clusters were separated by ~1700 AU, which is many times the maximum size scale usually associated with H_2O masers in AGB stars. The masers clearly obey any definition of "jet-like" having a width to length ratio of 1:85. We were able to measure the proper motions of the masers and could deduce a 3-D separation speed of 290 +/− 20 km s^{-1}. We believe this to be the first molecular jet with these extreme characteristics to have been observed.

Our data also suggest that the jet is precessing. Figure 4 shows a fit of a precessing jet model to the data from one epoch. Our model molecular jet has the following parameters:

velocity = 150 km s^{-1};	inclination angle = 39°;	pos angle = 65°;
amplitude = 5°;	period = 55 years.	

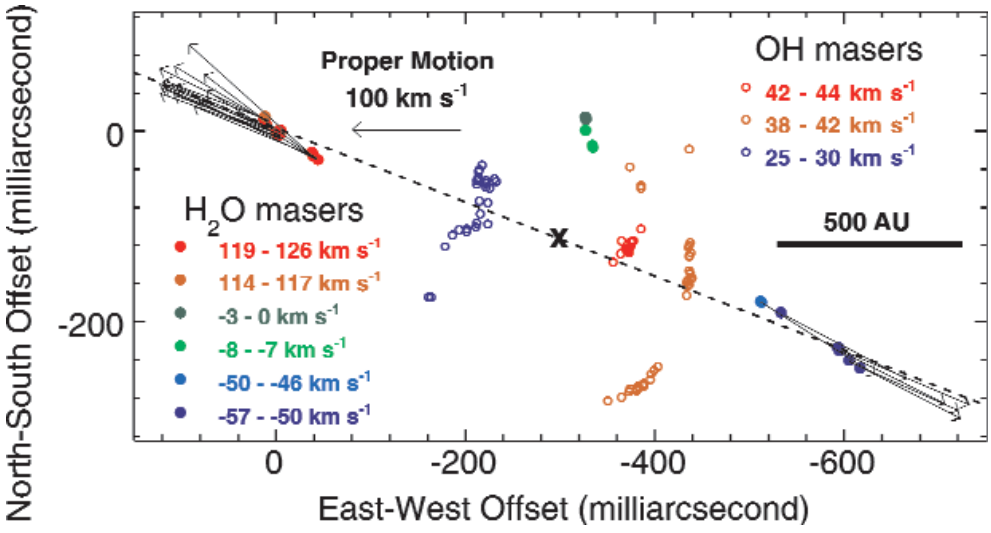

Figure 3: a summary of the spatial structure and kinematics of the OH and H_2O masers towards W43A.

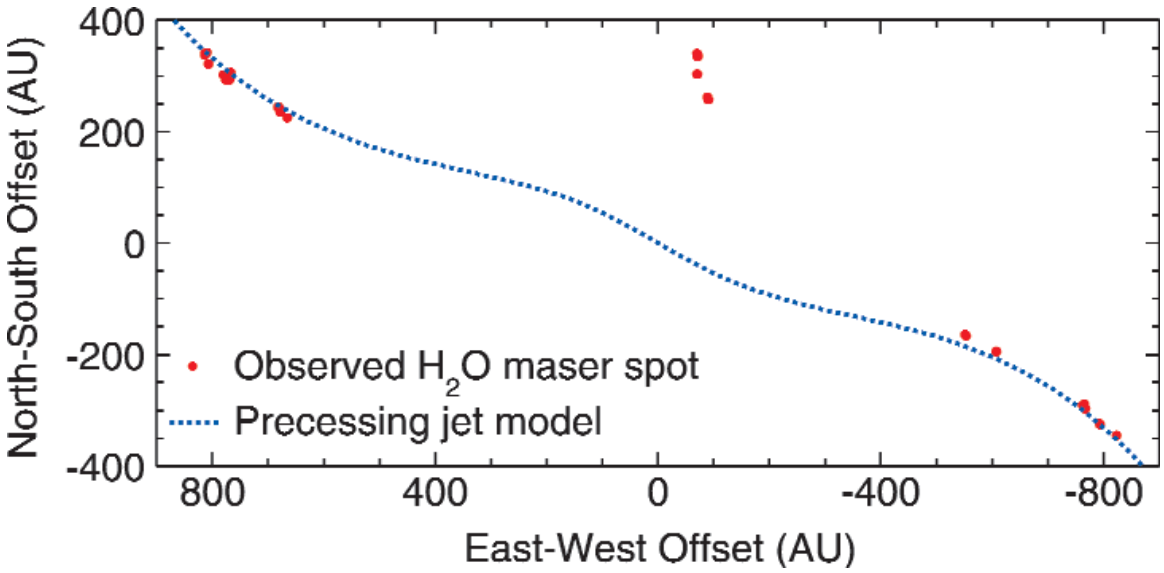

Figure 4: The angular distribution of H_2O masers detected on October 10, 1994, fitted with the pattern expected from a precessing jet model.

The dynamical age of the jet is ~28 years. This datum, combined with the presence of OH and SiO masers strongly suggest that we have caught W43A in transition as it passes from one stage of evolution to its final resting state as a white dwarf. A paper describing the observations in more depth has recently appeared in *Nature* (Imai et al., 2002).

We are obtaining more data on W43A. We have further VLBA epochs on tape and are hopeful of measuring OH proper motions as time has passed. We are trying to determine the position and structure of the SiO masers; hopefully they will enable us to pin down the position of the AGB star more accurately than that derived from our model-fitting. This may well enable us to determine if the star is a binary, since we should also be able to locate the base of the jet.

The study of W43A has a twenty-five year history. It was discovered as a star having high velocity water-vapor maser emission in 1976; Phil Diamond made low-resolution images of OH and H_2O and with Lars-Ake Nyman (ESO) searched for tracers of star-formation. Diamond, along with Tony Beasley (CARA), obtained the VLBA data in 1994-1995. It lay dormant in the archive until uncovered by Hiroshi Imai of the VERA project. Kumiko Obara of Kagoshima University then reduced the data supervised by Toshihiro Omodaka, Tetsuo Sasao, and Hiroshi Imai.

Phil Diamond, Jodrell Bank Observatory, University of Manchester

Hiroshi Imai, Joint Institute for VLBI in Europe

Kumiko Obara, Misuzawa Astrogeodynamics Observatory

Toshihiro Omodaka, Kogoshima University

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"What's New at the VLA?": *http://www.aoc.nrao.edu/vla/html/VLAnews.shtml*

NRAO Products

NRAO provides web access to the results from a number of radio surveys, including the following:

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/*

In addition, the NRAO maintains an archive of all observations. These may be queried via the web:

VLA database archive: *http://www.aoc.nrao.edu/vla/vladb/VLADB.html*
VLBA cumulative list of observed sources: *http://www.aoc.nrao.edu/ftp/cumvlbaobs.txt*

Observing Information

VLA: *http://www.aoc.nrao.edu/vla/html/vlahome/astronomer.html*
VLBA: *http://www.aoc.nrao.edu/vlba/html/vlbahome/observer.html*

Information on proposal templates, instructions, and deadlines can be found at:
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