



# NRAO NEWSLETTER

1990 January 1

No. 42

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## IN GENERAL

### 1990 BUDGET

When this Newsletter went to the printers the Observatory had not received official notice of its budget level for 1990. However, it is anticipated that the total budget for operation of all the NRAO instruments and construction of the VLBA will be roughly the same as for 1989. The financial resources available to NRAO for these activities are thus reduced in 1990 with respect to 1989 by inflation. Funding for design of the GBT is not affected.

The Observatory will operate all its user facilities in 1990, including the 12-meter telescope. This is made possible by deferring certain VLBA construction expenses to 1992. The deferred items have been selected to have the least effect on the pace of construction.

VLBA operations will increase by a modest amount in 1990 to allow for the addition of the Los Alamos antenna to Network Users Group VLBI observing sessions. This will make a total of three VLBA antennas available to users in 1990; details are given in the VLBA article in this Newsletter.

The pace of development of new instrumentation will be slowed by the funding limitations. We hope to see this activity restored to an appropriate level in FY 91.

P. A. VANDEN BOUT

### AUSTRALIA TELESCOPE OBSERVING TIME

Observing time is available on the Australia Telescope (AT), Parkes Telescope, and the Parkes-Tidbinbilla Interferometer. The proposal deadlines for each quarter are November 9 (*first*), February 9 (*second*), May 11 (*third*), and August 9 (*fourth*). Proposals should be sent to G. A. Manfield, Secretary, Parkes Time Assignment

Committee, Australia Telescope National Facility, P. O. Box 76, Epping NSW 2121, Australia. Forms are available from the same address or by contacting Phyllis Jackson, NRAO Charlottesville (804 296-0221).

P. A. VANDEN BOUT

### MILLIMETER ARRAY WORKSHOP

In mid-November 1989 more than seventy astronomers met at the Array Operations Center in Socorro for a workshop on the scientific rationale for the Millimeter Array. Representatives from many observatories, existing and planned, covering the spectrum from gamma rays to decametric radio waves, discussed the direction of scientific research at their institutions. Attendees then divided into groups to prepare reports on the science the array will

address. These reports will constitute a revision of the Proceedings of the first NRAO workshop on the Millimeter Array, "Science with a Millimeter Array," which set specifications for the design. A summary of the reports will be outlined in the next issue of the newsletter.

H. A. WOOTTEN

### WORKSHOP ON "PARSEC-SCALE RADIO JETS"

This workshop was held at the AOC in Socorro on October 18-19, 1989. During the two-day meeting, recent observations and theoretical models concerning compact radio jets were discussed by more than 60 participants.

Proceedings (edited by J. A. Zensus and T. J. Pearson) will be published by Cambridge University Press in the spring of 1990.

J. A. ZENSUS

## VLBA

### SELECTED ITEMS

**OPERATION** - The Fort Davis, TX antenna observed "first light" in early December. In October the first three-site VLBA network (Pie Town, Kitt Peak, and Los Alamos) yielded MK II fringes at 18 cm in a test run. Both Pie Town and Kitt Peak sites participated in the November 3.6 and 18 cm Network observations, plus Crustal Dynamics observations during October and December.

**GENERAL** - A stubborn manufacturing problem persists for the VLBA correlator's "FX" chip. The accumulated vendor delays for this chip have already caused a twelve-month slippage of the completion date for the seven-station subset VLBA correlator, to fourth quarter 1991, and a further three-month delay is not unlikely.

To obtain a more accurate evaluation of the surface accuracy of the VLBA antenna's reflector, a series of 86 GHz observations were performed at Pie Town by C. Walker and D. Bagri. A room temperature, non-phase-locked receiver made by NRAO Tucson was used for observations of Jupiter. The overall antenna efficiency ob-

tained was 18 percent  $\pm$  2 percent at 86 GHz. Keeping in mind that Pie Town still uses a preproduction subreflector with twice the measured RMS surface irregularities obtained for subsequent production runs, this result implies a main reflector meeting surface accuracy specifications. An efficiency estimate for Pie Town after a production subreflector is installed is 25 percent or better at 86 GHz.

**CONSTRUCTION** - Test, debugging, and evaluation continue at the Fort Davis antenna. At Owens Valley, erection of the antenna is almost completed. At Brewster, WA erection of the antenna is about 50 percent complete and scheduled for completion in April. At St. Croix, site preparation has been halted due to the aftermath of Hurricane Hugo causing delays. At Hancock, NH construction of the antenna foundation and site preparation continue. At Mauna Kea, site acquisition problems have been resolved and construction bid preparation is underway.

K. J. STETTEN

## GREEN BANK

### GREEN BANK TELESCOPE ADVISORY COMMITTEE MEETING

The Advisory Committee met December 14 and 15, 1989 to review the status of the Green Bank Telescope Project. Committee members who attended were Carl Heiles, U. California, Berkeley; Sebastian von Hoerner, NRAO ret.; Richard Jennings, U. Virginia; Jerry Nelson, Lawrence Berkeley Laboratory; Joe Taylor, U. Princeton; Sandy Weinreb, Martin Marietta; and Bob Wilson, AT&T Bell Labs.

The conceptual telescope presented for discussion is parabolic with a clear projected aperture of diameter 100 meters. The feed support arm is on the top of the primary reflector, braced by two members also completely outside the projected aperture. The alt-az drive of the telescope provides full sky coverage and slews at the same rate as the VLA antennas. The surface is adjustable, aiming for an accuracy that would permit 43 GHz observations initially and considerably higher frequencies when a suitable surface measuring scheme is developed. The telescope would have both prime and secondary foci. Two Gregorian subreflectors would illuminate the secondary

focus, one approximately 7 meters in diameter with a surface sufficient for operation between about 1 and 9 GHz, the other about 3 meters in diameter for operation between about 6 and 115 GHz.

Among the major issues discussed by the Committee were: (1) manufacturing accuracies of the panels and how they were to be mounted on the backup structure; (2) the field of view of the telescope, with an eye toward future focal-plane arrays of receivers; (3) the mechanism for surface control and its relationship to the telescope's pointing; (4) the fraction of the money that should be spent on electronics; and (5) the need for contingency in the budget.

The GBT Project goal is to complete a conceptual design that can form the basis for a Request for Proposals to be offered in the summer of 1990, with the aim of letting a contract for both detailed design and construction in the spring of 1991.

G. A SEIELSTAD

## 7-FEED, 5 GHz RECEIVER TO SURVEY ENTIRE SKY

The 7-feed, 5 GHz receiver completed a survey of the northern sky, declinations  $0^\circ$  to  $70^\circ$  using the 300-ft telescope. This survey, completed to about 25 mJy, detected approximately 50,000 radio sources. The sensitivity of the receiver has been improved by replacing FET amplifiers with HEMT amplifiers, and will in early 1990 complete a survey between declinations  $0^\circ$  and  $-40^\circ$  using the 140-ft telescope. Because of the 140-ft telescope's higher efficiency and solid surface (eliminating ground pickup through the mesh, as was the case for the 300-ft telescope), the difference in sensitivity of the two surveys is slight.

In the second and third quarters of 1990, the receiver will be installed on the CSIRO 210-ft telescope in Parkes, Australia, where it will survey the Southern sky to close to the South Celestial Pole. This should provide uniform coverage of almost the entire celestial sphere to excellent sensitivity. A final catalog will exceed 100,000 sources.

The effort is a joint project involving MIT, CSIRO, and NRAO.

G. A. SEIELSTAD

## 12-METER

### EIGHT BEAM RECEIVER AND HYBRID SPECTROMETER IN USE

The 230 GHz, eight-beam receiver and the new hybrid spectrometer are now in regular use by visiting observers. The first production observations were performed in December by Marc Kutner and David Adler. (We thank Marc and David for their cheerful service as "guinea pigs.") We are steadily ironing out the wrinkles in the system, and the data are rolling in quite reliably. The receiver tunes from approximately 215 to 240 GHz. The beam rotator is also working well. This permits the  $2 \times 4$  array of beams to track parallactic angle and so keep the mapping grid fixed in an RA/DEC frame as the source moves in azimuth and elevation. The array of beams can track an arbitrary fixed position angle, allowing the array to take full advantage of

the geometry of the source (e.g., by being aligned along the major axis of a galaxy).

All eight-beam observations are taken through the new hybrid spectrometer, giving 192 spectral points, with a maximum of 300 MHz bandwidth, in each of the eight beams. Two of the eight beams are also recorded simultaneously through the filter bank system, which has been extremely useful during the test phase in providing an independent check on hybrid spectrometer performance. All comparisons between the hybrid spectrometer and the filter banks have been extremely favorable.

D. T. EMERSON AND P. R. JEWELL

### NEW CONTROL SYSTEM MODULES SUCCESSFULLY TESTED

The 12-meter staff is currently engaged in a program to replace the existing telescope control system with a modern, flexible system. The new control system is modular, with major control and data acquisition functions performed by independent microprocessor-based units. One advantage of this design is that these modules can be developed and tested independently. Several of the most critical modules have now been completed and tested at the telescope. Most notable of these is the tracking and antenna servo system. This system, which is controlled by a Motorola 68030 microprocessor running under the VxWorks system, has been successfully tested at the telescope twice, in November and in December. The stand-alone system is fully functional, and is able to track

both sidereal and ephemeris objects. The optical telescope was used to check accurate tracking of the system. This is the first time that the Kitt Peak 12-meter telescope has been controlled independently of FORTH.

In addition to the servo and tracking system, a status and monitor bus system, and control over frequency synthesizers have been tested. The work yet to be finished involves data acquisition, high level control and the user interface, and system integration. We plan to continue development and testing of the new control system with minimal impact on regular telescope observing time.

D. T. EMERSON AND P. R. JEWELL

# VLA

## VLA CONFIGURATION SCHEDULE

| <u>Configuration</u> | <u>Starting Date</u> | <u>Ending Date</u> | <u>Proposal Deadline</u> |
|----------------------|----------------------|--------------------|--------------------------|
| D                    | 02 Nov1989           | 29 Jan 1990        | 15 Jun 1989              |
| A                    | 23 Feb 1990          | 04 Jun 1990        | 15 Oct 1989              |
| A/B                  | 15 Jun 1990          | 02 Jul 1990        | 15 Feb1990               |
| B                    | 06 Jul 1990          | 27 Aug1990         | 15 Feb 1990              |
| B/C                  | 07 Sep 1990          | 24 Sep 1990        | 15 Feb 1990              |
| C                    | 28 Sep 1990          | 02 Jan 1991        | 15 Jun 1990              |
| C/D                  | 13 Jan 1991          | 30 Jan 1991        | 15 Jun 1990              |

The maximum antenna separations for the four VLA configurations are: A-36 km, B-11 km, C-3 km, D-1 km.

### Approximate Long-Term Schedule

|      | <u>Q1</u> | <u>Q2</u> | <u>Q3</u> | <u>Q4</u> |
|------|-----------|-----------|-----------|-----------|
| 1990 | A         | A         | B         | C         |
| 1991 | D         | A         | B         | B,C       |
| 1992 | C         | D         | A         | A,B       |
| 1993 | B         | C         | D         | A         |
| 1994 | A,B       | B         | C         | D         |

Observers should note that in the ensuing years of sunspot maximum, daytime observations at 327 MHz are unlikely to be successful in the smaller configurations because of solar interference and in the larger configurations because of a disturbed ionosphere. In particular, only the most urgent B configuration observations near 8<sup>h</sup> RA should be considered; C configuration observations near 15<sup>h</sup> RA will also be difficult.

B. G. CLARK

## ARCHIVE DATA ACCESS POLICIES

There have been some questions about access to old observations in the VLA archives. The policy on use of the archived data is as follows. First, data collected under a VLA "A" series proposal is to be used only by the proposers for the first eighteen months following the last observations done under that proposal. (This may be extended to a closely related proposal in a different array configuration.) Beyond that time it is available to the community at large. We request that the users of archival data attempt to contact the original observers, both as a matter of courtesy and because it might well save them a great deal of effort. (In the best case, the observer may have an adequate map lying around his desk that he just didn't feel worth publishing. In the worst case, he may explain why the data aren't worth bothering with.)

For phased array VLBI observations, VLBI Network or VLBA "B" series proposals, an indication of interest on the part of the observers prior to the observations (a brief

e-mail message to B. Clark would suffice) would reserve the VLA data for them, provided there is no conflict of interest with a long-standing VLA proposal. If the observers have no interest in the VLA data, others may request the use of that data immediately and access will be granted, again providing there is no conflict of interest.

Please inform either Clark or Goss that you are accessing the data. If there is any question whether the data will meet the criteria above, contact them ahead of time.

The expectation is that users would come to Socorro to process old data. Data analysts will neither calibrate, nor fill, nor (usually) copy archival data.

B. G. CLARK AND W. M. GOSS

## VLA COMPUTER STATUS

On October 16 the DEC10 SYSTEM was finally turned off. This general-purpose computer served the VLA for almost 15 years. Several DEC10 peripherals were moved to the AOC for use on the two VAX 780 systems. The LP27 line printer is now available for text output. The Dicomed film recorder was moved to the AOC and will be connected to the YUCCA Convex C1. VLA data reduction at the site is limited to the OUTBAX VAX 750 machine. Since most data reduction will now be done at

the AOC, duplicate archive data tapes are made and sent there daily. These duplicate archive tapes numbered "DNxxxx" are stored in the AOC tape room. Original data archive tapes are stored at the VLA site and are not to be used except for making copies. Users needing archive tapes not in the AOC tape room should contact the computer operations group.

R. R. PAYNE

## OBSERVE

The replacement program for the DEC10 OBSERVE program has been in use since last summer. This new OBSERVE program is still under development, but is available on any NRAO VAX machine. For observers with access to a VAX machine, the program executable can be copied. Development of a PC version continues and should be available soon. Once users are happy with the design, the PC version will be converted to run on NRAO's UNIX machines.

The VLA computer division is committed to providing a flexible and easy to use OBSERVE program. Users have

complained about the complex interface and the execution speed of the current release. Efforts are being made to address both of these issues. Peggy Perley, Frazer Owen, and Elias Brinks have been asked to assist in guiding the future development of the program. If you have suggestions or comments concerning the OBSERVE program, please send them to Peggy Perley.

R. R. PAYNE AND P. A. PERLEY

## SOLAR OBSERVE

The new OBSERVE program does not yet support solar system objects. A software package designed to assist users in setting up observations of solar system objects has been installed on the NRAO guest accounts. At present, only solar observing programs are supported. The program is invoked by typing SOLOBS. An introduction

to SOLOBS is displayed by typing SOLDLOC. All questions, comments, and criticisms should be directed to Tim Bastian (Socorro).

T. S. BASTIAN

## VLA OBSERVING FILES

All OBSERVE files must now be mailed electronically to the VLA operators (NRAO address of OBSERVE). Although this seems to be working well, there are two potential problems. The first concerns the network link. If there is a failure in the transmission of the file to the operators' account on the VAX at the VLA site, the operations group will generally not be aware that it has been sent. The second problem concerns the fact that the operator sometimes needs additional information (e.g., special instructions, integration times, number of antennas, etc.) which should be conveyed along with the OBSERVE file. Observers have tended to be somewhat lax in this

latter area. Permission to exceed these guidelines can only be obtained from M. Goss or B. Clark. In particular, observers must conform to the adopted limits for on-line integration time. The operators will attempt to contact observers who have submitted OBSERVE files which violate these guidelines. If there is insufficient time for the observer to correct the error, the operators will attempt to do so. However, there is no guarantee that this will be done correctly. Adequate pre-planning is the best guarantee against errors!

R. C. BIGNELL

## NEW ON-LINE AVERAGING RESTRICTIONS

In order to easily manage the data volume passing through the NRAO's computers, VLA management some time ago set stringent limitations on the time averaging allowed by the VLA's on-line computers. These policies severely restricted the available field-of-view for imaging, especially for spectral line modes, and also greatly limited data editing possibilities.

Two changes have allowed review of this policy: First, AIPS calibration is now fully functional, and available at all sites having the 15OCT89, or later, release. A significant fraction of the VLA's data is expected to be calibrated outside the Observatory's computers. Secondly, the disk resources of the Observatory's computers have increased significantly, allowing greater data volumes to be held. In addition, it is believed there exists sufficient processing capability to handle a modest increase in data flow. Thus, it was decided to relax these on-line restrictions. Effective January 1, 1990, the following, more liberal, restrictions will be enacted (averaging time in seconds):

| Configurations | Cont | No. of Channels |    |    |    |     |     |     |
|----------------|------|-----------------|----|----|----|-----|-----|-----|
|                |      | 8               | 16 | 32 | 64 | 128 | 256 | 512 |
| C and D        | 30   | 30              | 30 | 30 | 30 | 30  | 60  | 120 |
| A and B        | 10   | 10              | 10 | 10 | 15 | 30  | 60  | 120 |

## SPECTRAL LINE SOFTWARE

The software available for Spectral Line calibration and reduction has undergone substantial change since the move from the site to the AOC. The shut-down of the DEC-10 caused not only the loss of a proven suite of calibration programs but also the loss of the Pipeline. In order to replace the DEC-10/Pipeline, a calibration package was developed at the VLA, based on the old DEC-10 programs, to run on the CONVEXes. This package, called ISIS, will look very familiar to the visitor who used to reduce data at the VLA site since it provides all the old programs and more. ISIS has been extensively run over the past six months. It is in a stable state now and all remaining activity is directed to normal maintenance and the repair of minor bugs. Visitors who wish to use ISIS for their calibration are welcome to do so. It should be noted, however, that ISIS is a local package and that the NRAO will not support its installation at other sites. In practice this means that a calibration started in ISIS should be carried through to the end, i.e., at least until writing the calibrated UV-data on a FITS tape. Two documents exist which explain the use of ISIS: "An Introduction to ISIS" by R. Hjellming and "Spectral Line Calibration in ISIS" by J. van Gorkom. Both documents can be obtained from Theresa McBride at the AOC, Socorro.

The number of channels listed is the total number of spectral line channels summed over all correlator products.

As before, these restrictions apply only to data being calibrated on NRAO's computers. If your data will be calibrated elsewhere, you may use any averaging time permitted by the correlator. Exemptions from these rules can be granted by Barry Clark or Miller Goss. If you feel you have a good reason for needing a shorter averaging period (for example, a large object being observed in the A or B configurations), you must obtain permission before your OBSERVE file is sent to the operators. The operators will not be responsible for correctly changing the DS card to conform with these rules. In addition, you must contact the operator before sending the file, informing him that permission has been granted.

R. A. PERLEY

The demise of the DEC-10 package has also increased the use of the calibration package which runs within AIPS. The 15OCT89 release of AIPS supports the calibration of spectral line data. This means that an observer can do the entire calibration, reduction and analysis within the same environment. Additionally, the user can choose either to come to the AOC or Charlottesville, or to process data at his home institution. Although the philosophy behind the calibration of spectral line data remains the same, the AIPS package has its own approach. A preliminary comparison between ISIS and AIPS shows that both give the same, hopefully correct, answers and that they are equivalent in speed. A draft document describing calibration in AIPS will be included as a chapter in the revised AIPS Cookbook. Copies can be obtained from Theresa McBride (Socorro). The 15OCT89 version of AIPS contains a number of bugs which affect spectral line reductions. Corrected source code for the offending programs is available to be copied with the AIPSSERV facility. (See the 15OCT89 AIPS Newsletter for details.) The 15JAN90 AIPS release will, of course, include the corrected versions.

E. BRINKS

## VLA OBSERVING PROPOSALS

As noted in a previous Newsletter article, a number of VLA spectral line proposals have been received with incorrect, inconsistent or out-of-date correlator configurations. A common error is the request for 128 channels with a bandwidth of 12.5 MHz. The latest VLA Status Report (1989 and soon to appear 1990) should be consulted. Tables VI(a) and VI(b) give the correct bandwidths and number of channels. A new version of the Spectral Line Guide by A. Rots will also appear in early

1990. Many spectral line proposals also contain serious errors in the calculation of the noise in a one-hour integration. Obviously, proposals with these types of errors have less credibility with the scheduling committee. Proposers should take greater care with these calculations if they do not wish to jeopardize this aspect of the proposal review.

W. M. GOSS

## NEW VLA CALIBRATOR MANUAL

A revised edition of the VLA Calibrator manual is now ready for distribution. This edition contains listings for 806 radio sources suitable for use as calibrators. It differs from previous editions in several major ways.

Important changes include the addition of listings for 90 and 3.6 cm and the inclusion of many new calibrators. Furthermore, as a result of new observations at 3.6 cm, all previous calibrator observations at other bands have been

uniformly reassessed, and many changes in the manual have resulted. This new manual is expected to be considerably more complete and reliable than all former editions. Copies may be obtained from Theresa McBride at the AOC. We are currently developing a simple electronic distribution system for both the manual and the associated text. This should be ready before the next edition of the newsletter.

R. A. PERLEY

## ON-DUTY SCIENTIST SUPPORT AT THE AOC

Upon arrival at the Array Operations Center, each visiting observer requesting assistance is assigned a staff "friend" to assist in his observing and data processing. The assigned friend generally will be available at the AOC for consultation and assistance during normal working hours. However, recognizing that the "friend" cannot be expected to match exactly the visitor's working hours, we have reinstated the "on-duty scientist" program.

For each week-day evening, and for daytime hours on weekends and holidays, an NRAO staff scientist or scientific programmer will be available in the AOC to assist visitors. The sign-up list is posted on the bulletin

board in the coffee area of the second (ground) floor of the AOC, and copies are periodically posted in the Convex AIPS Cages. Visitors needing advice or assistance with their observing or data reduction during off-hours are urged to consult with the on-duty scientist. If the question or problem is particularly difficult and lies beyond his or her expertise, the on-duty scientist will refer to a more knowledgeable expert, or the assigned "friend." In any event, the intention is to prevent visitors from floundering due to relatively simple problems and to shorten the response time to more serious ones.

R. A. PERLEY

## THE 1990 VLA STATUS REPORT

At the end of each year, the VLA staff revises and reissues the VLA Status Report. This short document summarizes the instrumental capabilities of the VLA and the data calibration and imaging capabilities available to visitors who use the NRAO software to process their VLA data. It is expected that the 1990 edition will be ready by

January 1. Copies are mailed to all recent VLA users. If you wish to obtain a copy, please contact Sandra Montoya at the AOC.

R. A. PERLEY

## SOCORRO ACCOMMODATIONS

Accommodations for visiting scientists in the AOC in Socorro have been reduced in number from six to only three in order to make room for expansion of our engineering department. The good news is that this is in anticipation of future support for VLBA operational activities. The bad news is that more of our visitors will be forced to brave the elements when they retire to their chambers after long hours at the computer terminals. Our

long-term plan is still to construct a nearby VSQ for the convenience and comfort of our users. Meanwhile, inexpensive accommodations are provided in the basement of Fitch dormitory, a five minute walk from the AOC on the campus of NMIMT.

R. J. HAVLEN

## SOCORRO SHUTTLE

The Socorro Shuttle Service now has a new schedule that makes it even more convenient to travel between the Albuquerque Airport and the AOC (door to door):

### Depart Socorro    Depart Albuquerque

|          |          |
|----------|----------|
| 0500 hrs | 0700 hrs |
| 0730     | 0930     |
| 1000     | 1200     |
| 1230     | 1430     |
| 1500     | 1700     |
| 2000     | 2200     |

Reservations are required and may be made directly to (505) 835-0040. Travel changes that affect your reservations must also be communicated directly to Socorro Shuttle Service as soon as possible in order to avoid a "no show" charge. In this sense, please treat this service as the equivalent of a radio taxi rather than a city bus lines. You may be their only fare.

Reservations may also be made through Eileen Latasa at the AOC (505-835-7357) while you are making the other arrangements for your visit to the AOC/VLA.

R. J. HAVLEN

## TRAVEL REIMBURSEMENTS

VLA travelers who have received a smaller air fare reimbursement than they expected from NRAO should heed the present announcement. All reimbursements are computed on the basis of the lowest published fares consistent with your days of departure and return. If your actual fare is larger than this amount for reasons beyond

your control, please document this for us when you request your reimbursement. Unless evidence is presented to the contrary, we will always assume that you could have (or should have) obtained the lowest available fare.

R. J. HAVLEN

## RECENT VLA AND MILLIMETER ARRAY MEMORANDA

The following recent VLA Memoranda have been issued since the last NRAO Newsletter:

Computer Memorandum #181, "The Relative Performance of AIPS and ISIS," by R. Perley, P. Diamond, C. Flatters (09/89).

Electronic Memorandum #215, "Data Set 4 Command & Monitor Data," by P. Lilie (10/89).

Scientific Memorandum #161, "Correction Schemes for Polarized Intensity," by P. Leahy (12/89).

Millimeter Array Memorandum #58, "Millimeter Wave Atmospheric Opacity and Transparency Curves," by F. Schwab, D. Hogg (10/89).

Copies of any VLA numbered memorandum or a copy of the listings of all VLA numbered memoranda are available from Sandra Montoya (NRAO, P. O. Box O, Socorro, NM 87801 [(505) 835-7310].)

S. MONTOYA





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