NRAO eNews

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Upcoming Events

ALMA Software Development Workshop (https://science.nrao.edu/facilities/alma/naasc-workshops/almasoft2011)
Oct 12 - 14, 2011 | Charlottesville, VA

NRAO Town Hall at the 219th AAS (https://science.nrao.edu/science/aas/219/nrao-town-hall-at-the-219th-aas)
Jan 10, 2012 | Austin, TX

ALMA Special Session at the 219th AAS (https://science.nrao.edu/science/aas/219/alma-special-session-at-the-219th-aas)
Jan 11, 2012 | Austin, TX

Outflows, Winds and Jets Workshop (https://science.nrao.edu/facilities/alma/naasc-workshops/jets2012)
Mar 3 - 6, 2012 | Charlottesville, VA

ALMA Cycle 0 Early Science Underway

(images/ALMA_19antennas_b.jpg)

Figure 1: Nineteen ALMA antennas on the Chajnantor plateau in northern Chile, just prior to the start of ALMA Early Science. Credit: (ESO/NAOJ/NRAO), W. Garnier (JAO).

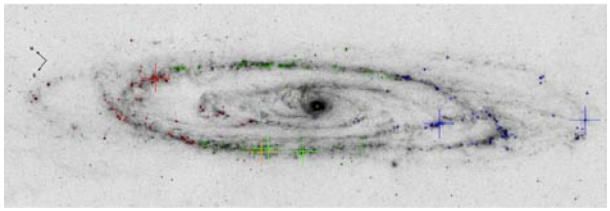
Zoom (images/ALMA_19antennas_b.jpg)

On behalf of the partner organizations and all the personnel in Chile, East Asia, Europe, and North America involved in bringing ALMA to Early Science readiness, the NRAO is proud to announce that the Joint ALMA Observatory officially began Early Science Operations on schedule on Friday, 30 September. Press

releases from the **NRAO (http://www.nrao.edu/pr/2011/almaearlysci/)** and the **NSF (http://www.nsf.gov/news/news_summ.jsp?cntn_id=121881&org=NSF&from=news)** provide additional information on this historic ALMA achievement, including **images and HD video (http://www.nrao.edu/pr/2011/almaearlysci/images.shtml)**, and a **webcast (http://www.nsf.gov/news/news_videos.jsp?cntn_id=121881&media_id=71260&org=NSF)**. The first astronomical images from ALMA are also **on-line (http://www.nrao.edu/pr/2011/almafirstpics/)**. Thirteen of the state-of-the-art antennas built by **General Dynamics (http://www.multivu.com/mnr/52410-general-dynamics-antennas-for-world-s-largest-radio-telescope)** SATCOM Technologies are in the array that has initiated Early Science on the Chajnantor plateau in Chile.

Hit or Miss: Will the Andromeda Galaxy Collide with the Milky Way?

Jeremy Darling (University of Colorado)



(images/figure1_1.png)

Figure 1. A Spitzer 24 micron map of M31 (Gordon et al. 2006). The circles indicate the 206 pointing centers (the circles are to scale, showing the Green Bank Telescope beam). Crosses mark the detected water masers and are enlarged for clarity. The orange cross indicates the 6.7 GHz methanol maser detected by Sjouwerman et al. (2010). Colors indicate the systemic (green), red-, and blue-shifted spectrometer tuning centers at -300, -100, and -500 km/s, respectively. Figure and caption after Darling (2011).

Zoom (images/figure1_1.png)

The Milky Way's sister galaxy, the Andromeda Galaxy (M31), is hurtling toward the center of the Milky Way at 122 kilometers per second [1]. Measuring the Doppler shift of M31 tell us the motion along our line-of-sight, but not Andromeda's transverse motion. It might be on a collision course with the Milky Way, it might give us a glancing blow, or it might miss us entirely. To determine the 3-D velocity vector of the Andromeda Galaxy, we must measure its proper motion. The problem is that this is a galaxy at a distance of ~ 800 kiloparsecs, so even an enormous transverse velocity translates into a miniscule angular motion. With a ground-based optical telescope, one would need to monitor the location of the Andromeda Galaxy with respect to distant background quasars for thousands of years to see this motion. Happily, impatient astronomers have found ways around this problem: they can do something clever from the ground [2], go to space, or use a radio interferometer.

If very compact and bright sources of radio waves can be identified in the Andromeda Galaxy, then one can use Very Long Baseline Interferometry (VLBI) to synthesize a radio dish roughly as large as the Earth, producing very high angular resolution. VLBI makes it possible to measure the proper motion of nearby galaxies in only a few years [3,4], and the key is to use molecular masers as the extremely bright, compact reference points to monitor against distant quasars.

The persistent problem with applying this technique to the Andromeda Galaxy has been finding the requisite masers: the galaxy is too large on the sky to survey efficiently with enough sensitivity to detect masers analogous to those we see in the Milky Way. The solution to this problem lay in using the sensitive Green Bank Telescope and knowing where to point it. Using Spitzer Space Telescope infrared maps of the Andromeda Galaxy [5], we selected regions of on-going star formation where masers are likely to occur [6]. Among 206 regions surveyed, we detected five water maser-emitting regions that can now be used for proper motion measurements (Figure-1). Sjouwerman and collaborators have likewise detected the first methanol maser in a survey of Andromeda's star-forming ring [7].

Remarkably, we expect to see three different types of proper motion in the Andromeda Galaxy: (a) the proper motion of the galaxy as a whole across the plane of the sky; (b) the real-time rotation of the galaxy, which can provide a geometric distance measurement; and (c) an apparent expansion of the galaxy on the sky as it approaches us, which can provide an additional independent geometric distance measurement. Also, once the 3-D velocity of the Andromeda Galaxy is known, not only can we address the "hit or miss" question, but we can also study the total mass and distribution of dark matter in the Local Group of galaxies, which is key to our larger understanding of galaxy evolution and cosmology.

An observational program to measure the proper motions of water masers in the Andromeda Galaxy, in collaboration with Andreas Brunthaler and Mark Reid, is now underway. We expect to obtain the proper rotation and proper motion of the Andromeda Galaxy in about 3 years of observation. The apparent expansion measurement will likely require a decade.

Notes & References

[1] From our vantage point in a spiral arm roughly halfway out from the Galactic Center, we see M31 approaching at 300 km/sec.
[2] van der Marel, R. P. & Guhathakurta, P. 2008, ApJ, 678, 187
[3] Brunthaler, A., et al. 2005, Science, 307, 1440
[4] Brunthaler, A., et al. 2007, A&A, 462, 101
[5] Gordon, K. D., et al. 2006, ApJ, 638, L87
[6] Darling, J. 2011, ApJL, 732, L2 (http://iopscience.iop.org/2041-8205/732/1/L2)
[7] Sjouwerman et al. 2010, ApJ, 724, L158

Massive Galaxy Formation in the Early Universe: the GN20 Protocluster

Chris Carilli

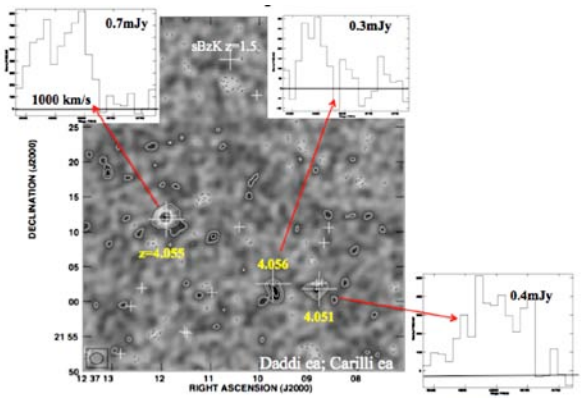


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Figure 1. EVLA images and spectra of the CO emission in the GN20 protocluster of molecule-rich galaxies at z ~ 4.05.

Zoom (images/figure2_1.png)

Numerous lines of evidence support the hypothesis that massive elliptical galaxies form the majority of their stars quickly at early epochs. Plausible progenitors for these massive galaxies are high redshift submillimeter galaxies (SMGs), corresponding to dusty, luminous starburst galaxies found in wide-field submillimeter surveys. These hyper-luminous high-z galaxies trace high over-densities and are likely related to the formation of clusters and large ellipticals.

Daddi et al. (2009 ApJ, 694, 1517) have identified a unique region in GOODS-N, containing three SMGs, each at z~ 4.05, within 20 arcsec of each other: GN20, GN20.2a, and GN20.2b. The IR luminosities are of order 10^{13}L(sun), with implied star formation rates >1000 M(sun)/year. This group of galaxies is the ideal laboratory for studying the formation of massive galaxies via luminous, gas-rich starbursts within 1.6 Gyr of the Big Bang.

Using the unique new spectral capabilities of the Expanded Very Large Array, we have imaged the CO 2-1 and 1-0 emission from the GN20 proto-cluster (**Carilli et al. 2011, ApJ, 739, L33 (http://iopscience.iop.org/2041-8205/739/1/L33)**). We detect all three galaxies, with molecular gas masses between 10^{10} and 10^{11}M(sun). The emission from the brightest source, GN20, is resolved with a size ~ 2 arcsec, and has a clear north-south velocity gradient, suggesting ordered rotation. The gas mass in GN20 is comparable to the stellar mass, and the sum of gas plus stellar mass is comparable to the dynamical mass of the system within a 5kpc radius. We hypothesize that GN20 may be a massive, gas-rich disk that is gravitationally disturbed, but not completely disrupted.

A key question for the SMGs is: What drives the prolific star formation? For GN20, it is possible that a combination of effects is occurring: generation of a gas rich disk via efficient 'cold mode' accretion of gas from the intergalactic medium, and subsequent gravitational perturbation by the neighboring galaxies. Further high resolution observations are in progress to map the gas, dust, and star formation in GN20 and its companion galaxies at kpc-resolution.

OSO Users Forum

Anthony Remijan

Interested in what other NRAO users are going? Have you developed a great reduction script or observing strategy that you want to share with others in the community? Are you interested to know whether other NRAO users have the same questions you do? Need a place to bounce around ideas?

The Observatory Science Operations (OSO) Office is pleased to announce the deployment of the NRAO Science Forum for the entire scientific community. The NRAO Science Forum provides the observatory's users with an interactive, online environment for general discussions on science, project planning, observing strategies, data reduction, data analysis and archive access. Users are free to exchange questions, offer ideas and suggestions and share tips and tricks with each other. Overall, we hope the NRAO Science Forum will be a great source for user education, communication, and troubleshooting.

Starting 5 Oct 2011, the NRAO Science Forum will be released for public use with the main forum topic being the Common Astronomy Software Applications (CASA) package. Access to the forums will be available at ***science.nrao.edu/forums***. User forums and discussions can be viewed by the entire community and are fully searchable through all standard search engines (e.g. Google). To post to a forum topic, users must be authenticated through the NRAO portal at ***my.nrao.edu***. In addition to viewing threads on interesting discussion topics, the Science Forum can be customized by a user to receive alerts when a new post is added to a topic, to tag each topic with common elements, and to post to the database scripts and procedures for discussion by the user community.

Since this is a forum for users to exchange and discuss their problems, ideas, reduction scripts, NRAO staff will play a limited moderation role. If a problem cannot be solved from within the group of users, we prefer that a Helpdesk ticket be submitted via our NRAO portals: help.nrao.edu (all NRAO questions outside ALMA) and help.almascience.org (ALMA).

For questions about the NRAO Science Forum, please contact Anthony Remijan, Manager of Observatory Science Operations, at **aremijan@nrao.edu (mailto:aremijan@nrao.edu)**.

ALMA Construction & Early Science

Al Wootten

(images/ALMA_19antennas_b.jpg)

Figure 1: Nineteen ALMA antennas on the Chajnantor plateau in northern Chile, just prior to the start of ALMA Early Science. Credit: (ESO/NAOJ/NRAO), W. Garnier (JAO).

Zoom (images/ALMA_19antennas_b.jpg)

The complement of ALMA antennas at the 16,500ft elevation Array Operations Site (AOS) reached 20 during September. Sixteen 12m antennas were moved into position on the foundations selected for the beginning of Early Science in late September. To use the newly completed pads, complex power shutdowns were completed. Power must be restored quickly after these events so that the sensitive receiver elements do not warm up. One third of the contracted ALMA antenna total of 66 have now been accepted, outfitted and integrated into the array. A few of those antennas have been transported back to the lower-elevation Operations Support Facility (OSF) for component upgrades, after which they return to the AOS for use in Early Science and/or Commissioning activities.

A major technical problem of the ALMA Local Oscillator (LO) system is to maintain accurate phase stability in the signals used in the receiver components. The central reference part of the LO system is located at the AOS in the Technical Building. From here the signal is used to lock electronic oscillators and derived frequencies in antennas located at distances of many miles across the site via optical fiber. The outgoing frequency is transmitted as the difference between two laser frequencies in the infrared. The required phase stability of the LO signal is equivalent to less than 12 femtoseconds of time, less than 38 femtoseconds of phase noise. This time equivalent phase stability is to a second as a second is to 2.6 million years! The main LO system is named the Central Local Oscillator Article (CLOA). Installation and testing of the final stage of CLOA took place in August; it was accepted in September. The CLOA is now capable of supporting the 66 antennas and four subarrays built for the ALMA consruction project; it may be expanded to provide signals for up to six subarrays and eighty antennas.

During September, the complement of antennas was split for the first time into two subarrays, with signals from one subarray going to the main correlator (now with its second quadrant able to combine signals from 32 antennas), and signals from another going to the Atacama Compact Array (ACA) correlator delivered from Japan. This test was successful. During full operations, ALMA's powerful correlators can process signals from up to four independently-tuned subarrays.

Principal Investigators of 112 successful proposals of the 919 submitted for ALMA Early Science Cycle 0 time were informed of the news. Scientists at the Joint ALMA Observatory and the ALMA Regional Centers worked to translate those proposals selected for the initial complement of compact configuration observations into 'Schedule Blocks'. These are sequences of commands to the instrument to guide it through the calibrations and source observations needed for successful completion of the projects. Scientists at the ALMA Regional Centers in Europe, North America, and East Asia are working with the Principal Investigators to ensure successful project execution. End-to-end operations testing of selected high priority projects have been successfully completed on the array; the tests were successful though efficiency improvements were identified.

This Month @ the NAASC

ALMA Software Development Workshop

NRAO will host an **ALMA Software Development Workshop (https://science.nrao.edu/facilities/alma/naasc-workshops/almasoft2011)** 12-14 October 2011 in Charlottesville, Virginia to discuss software development

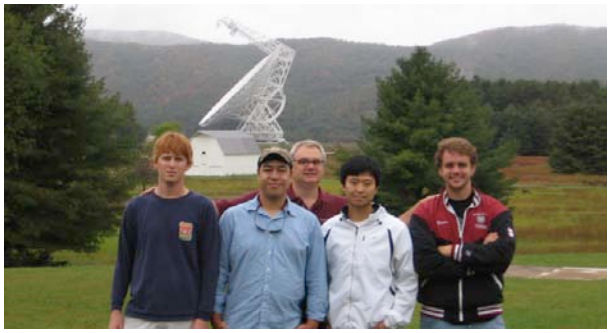
plans for ALMA and closely related telescopes. The goal is to generate a set of ideas for software applications that will enhance the science output from ALMA, and to stimulate the formation of consortia willing to submit these ideas to the ALMA Development Program for funding (including seed funding via NRAO and full funding via the ALMA Board) and/or the NSF directly. The workshop will concentrate on science data analysis of the large datasets that ALMA will produce. Topics will include line forest analysis, feature finding in large data cubes, matching data to simulations, visualization and compressive sensing.

Outflows, Winds and Jets: from Young Stars to Supermassive Black Holes

https://science.nrao.edu/facilities/alma/naasc-workshops/jets2012 (https://science.nrao.edu/facilities/alma/naasc-workshops/jets2012)

The NRAO North American ALMA Science Center (NAASC) will host its 6th annual science workshop – *Outflows, Winds and Jets: From Young Stars to Supermassive Black Holes* – in Charlottesville, Virginia, 3-6 March 2012. The venue is the Omni hotel, located conveniently near downtown Charlottesville. Pre-registration is open at the **conference web site (https://science.nrao.edu/facilities/alma/naasc-workshops/jets2012)**. Pre-registration is not required, but will ensure that you receive timely information about the conference program and logistics. Registration will open 1 November 2011.

Meet the NAASC



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Zoom (images/figure5_3_1.png)

Jonathan Keohane (center in image at left) is on sabbatical from teaching at Hampden-Sydney College, a private liberal arts college for young men. After receiving his B.S. in physics from Yale University, Jonathan completed a teacher education program at the University of Oregon and taught high school physics for two years before entering graduate school in astrophysics at the University of Minnesota. While completing his thesis work comparing X-ray and radio emission from supernova remnants, Jonathan spent three years in the Laboratory for High Energy Astrophysics at Goddard Space Flight Center in Greenbelt, Maryland. Jonathan then taught for five years at the North Carolina School of Science and Mathematics, where he involved his students in research using the Chandra X-ray Observatory. This was followed by a year long post-doc at the Spitzer Science Center, after which Jonathan joined the faculty at Hampden-Sydney College, where he has been teaching for the past seven years. Jonathan is spending his sabbatical year at NRAO developing curricula to support the teaching and learning of radio astronomy at the undergraduate and graduate levels. This especially includes work that supports the efforts of the NAASC to teach potential users of ALMA millimeter and submillimeter astronomy.

Recommendations for Computing Hardware for EVLA Data Reduction

Gustaaf van Moorsel

In the Expanded Very Large Array (EVLA) D-configuration starting 30 September 2011, observers will be able to make use of the new Open Shared Risk Observing instrument configurations. This not only means much wider bandwidths, but also potentially sharply increased data rates. Consequently, observers will have to be able to handle much larger data sets than they have been used to, and may have to upgrade or replace their computing hardware to reduce their data.

For instance, a 3-second integration time now results in a data rate of 17 GB/hour. A rule-of-thumb is that to comfortably reduce data an observer needs 5 - 10 times as much disk space as is needed to hold the visibility data alone. In the case of a 3-second integration time, observing for 6 hours will therefore require between 500 and 1000 GB. There will also be an increased need for CPU power, memory, and faster disk access.

Our understanding of what constitutes the ideal computing hardware setup is still evolving, but for the current recommendations please refer to our **Hardware Recommendations Page (https://science.nrao.edu/facilities/evla/data-processing/hardware-recommendations)**.

We will keep this page updated as technology and our own understanding evolves.

EVLA Data Reduction Workshop Report

Gustaaf van Moorsel

The first EVLA Data Reduction Workshop was held at the Domenici Science Operations Center in Socorro, NM 14 - 16 September 2011. The workshop's goal was to prepare experienced VLA and EVLA observers for the new challenges in reducing data taken with the much wider bandwidths (up to 2 GB) offered in the D-configuration starting 30 September 2011. The focus of this workshop was to go through detailed hands-on tutorials involving several types of EVLA data highlighting a number of challenging cases. In addition, one ALMA tutorial was available. Several talks were offered concentrating on areas of active study and development such as wideband wide field imaging and automatic RFI detection and excision. There were 39 participants, of which 30 came from outside NRAO. Assistance was provided by local NRAO staff scientists

during the hands-on tutorials. These tutorials are **on-line (https://science.nrao.edu/facilities/evla/early-science/data-reduction-workshop/program)** ; each tutorial includes information regarding data access.

The first reactions we have received to this workshop have been overwhelmingly positive. We plan to continue to hold these workshops on a regular basis, and will use the constructive feedback we have received to further improve them. We will also continue to organize our bi-annual Synthesis Imaging Workshops, which are more targeted at those who are new to Radio Astronomy/Synthesis Imaging. The next such workshop is tentatively scheduled for 29 May – 5 June 2012.

Career Opportunities

New Postings

Systems Administrator I: (https://careers.nrao.edu/applicants/Central?quickFind=50690) The NRAO in Socorro, NM is accepting applications for a Systems Administrator I. This position will support local technical and scientific staff Redhat Linux systems and assist in the development and maintenance of the EVLA and VLBA data archive, high performance computing systems.

ALMA Product and Quality Assurance Program Manager (https://careers.nrao.edu/applicants/Central?quickFind=50719) : (https://careers.nrao.edu/applicants/Central?quickFind=50688) The Joint ALMA Observatory (JAO) located in Santiago, Chile is recruiting for a Product and Quality Assurance (PQA) Program Manager. The PQA Program Manager will work closely with the Heads of the ALMA Departments of Engineering and Computing with respect to the definition and implementation of a quality management system for the engineering activities in Operations. The incumbent will also have a direct interaction with the Project Manager of the Construction project concerning the coordination of Construction related PA/QA activities.

Co-Op Student (https://careers.nrao.edu/applicants/Central?quickFind=50711) : (https://careers.nrao.edu/applicants/Central?quickFind=50689) The NRAO in Socorro, NM is seeking a co-op student to work in the Electronics Division. The work assignment will involve performing RFI and EMC testing at the Very Large Array. Tasks will include the collection, analysis and presentation of monitoring system data, the location, identification and mitigation of detected RFI, and performing RF power measurements in a RF reverberation chamber. This position is temporary full-time for a period up to six months.

Software Engineer II (https://careers.nrao.edu/applicants/Central?quickFind=50654) : (https://careers.nrao.edu/applicants/Central?quickFind=50664) The NRAO in Socorro, NM is accepting applications for a Software Engineer II. The successful candidate will work on one or more of the following applications: Observation Preparation Tool, Observation Scheduling Tool, and Archive Access Tool as well as perform routine maintenance and add new features to these tools. Initially the Software Engineer II will work primarily, but not exclusively, on user interface code for our web applications.

NAASC Postdoctoral Fellow (https://careers.nrao.edu/applicants/Central?quickFind=50690) :

(https://careers.nrao.edu/applicants/Central?quickFind=50665) The NRAO in Charlottesville, VA is seeking a postdoctoral fellow to work with the NAASC scientific staff. The successful candidate should expect to spend 50% of their time on independent research, with the remaining time spent on developing ALMA expertise and assisting the NAASC scientific staff in the support of ALMA users.

NRAO Postdoc: (https://careers.nrao.edu/applicants/Central?quickFind=50650) The NRAO in Socorro, NM is accepting applications for three postdoctoral positions to participate in the scientific commissioning and technical development of the EVLA and VLBA. These positions (50% research, 50% support) provide the opportunity for hands-on training in areas of technical expertise and observatory operations.

Jansky Fellow: (https://careers.nrao.edu/applicants/Central?quickFind=50689) The NRAO is recruiting for Jansky Fellows. The purpose of the Jansky Fellowship Program is to provide an opportunity for young scientists to establish themselves as independent researchers so that they may more effectively compete for permanent positions. Fellows formulate and carry out investigations either independently or in collaboration with others within the wide framework of interests of the Observatory.

NRAO Postdoc: (https://careers.nrao.edu/applicants/Central?quickFind=50695) The NRAO in Green Bank, WV is seeking a postdoctoral fellow to join their scientific staff. The NRAO Postdoc will have 50% of their time available for independent research and the remaining time will be devoted to support of the GBT and GBT observers.

Systems Administrator I: (https://careers.nrao.edu/applicants/Central?quickFind=50696) The NRAO in Charlottesville, VA is accepting applications for a Systems Administrator I. Under general supervision, the Database Systems Administrator will investigate reported issues and execute assigned implementation tasks for Oracle database and Linux server support.

Scientific Programmer: (https://careers.nrao.edu/applicants/Central?quickFind=50664) The NRAO in Charlottesville, VA is seeking a Scientific Programmer who will research and develop software to visualize and analyze ALMA data. The developer must become familiar with Common Astronomy Software Applications (CASA) code and practices, work within the existing CASA framework to improve and develop C++ code using the Qt platform, and extend the DBUS interface to enable interactive use of existing analysis tools within the CASA system.

Project Scientist (https://careers.nrao.edu/applicants/Central?quickFind=50650) : The NRAO in Green Bank, WV is recruiting for a Project Scientist. The successful candidate will provide scientific guidance to the project manager and project team; lead the testing and commissioning of the receivers on the 20 Meter Telescope; lead the development of a time allocation framework that enables scientific and educational users; and advise UNC scientists and programmers who are developing the user interface and data reduction tools as well as supervise early science with the 20 Meter.

Division Head (https://careers.nrao.edu/applicants/Central?quickFind=50655) : The NRAO in Green Bank, WV is seeking an enthusiastic and energetic person to head the Software Development Division. The Software Development Division head is responsible for managing the division as well as working with the other division heads in Green Bank to plan the future of the telescope and optimize its scientific use.

Papers of Woodruff T. Sullivan III

Ellen Bouton

The NRAO Archives is pleased to announce the availability of the Papers of Woodruff T. Sullivan III. Sullivan's book, *Cosmic Noise: A History of Early Radio Astronomy* (Cambridge University Press, 2009), discusses the history of radio astronomy through 1953, and represents 30 years of intensive research. In 2010 Sullivan donated to the NRAO Archives the 188 audio tapes and related paperwork for the extensive set of interviews he conducted between 1971 and 1988 with 255 radio astronomers around the world, many of whom are now deceased. The interview tapes are a unique resource for the history of radio astronomy, which was still a relatively young field when Sullivan began his interview project in 1971.

The 2011 Pollock Award from Dudley Observatory, made annually for a project in the history of astronomy or astrophysics, provided funding for a summer intern, Sierra Smith, who digitized the 22-40 year old audio tapes, and worked with NRAO Archivist Ellen Bouton to create the Web **finding aid (http://www.nrao.edu/archives/Sullivan/sullivan.shtml)** for the Sullivan papers as well as Web pages for individual interviewees. The finding aid includes links to the interviewee pages and also to the listing of conference talks and lectures on radio astronomy history and on SETI recorded by Sullivan.

It is standard practice for Archives to obtain signed permissions from interviewees before making interviews available to researchers, either in person at the Archives or on the Web. Ms. Smith also worked on contacting interviewees or their heirs for permissions, and the Archives now has signed permission forms from many interviewees. However, there are still people for whom we have been unable to find contact information, and we seek the help of readers of this newsletter. A list of interviewees for whom we lack addresses, either for the interviewee or for heirs/next of kin, is **on-line (http://www.nrao.edu/archives/Sullivan/addresses-needed.shtml)**. Please review the list, and e-mail the author (**ebouton@nrao.edu (mailto:ebouton@nrao.edu)**) if you are able to provide addresses or contact information for the listed interviewees or their heirs/next of kin, or for people who may know of appropriate addresses. Your help in making these interviews available to researchers will be appreciated.

Over the next year Dr. Sullivan will be donating the remainder of his research materials on radio astronomy history to the NRAO Archives. We are grateful to him for his gift, which provides an extraordinary resource for historians and researchers.

From the Archives

Ellen Bouton

(images/archives_1.png)

About this month's photograph: In August 1962, John D. Kraus was supervising the construction of the Ohio State University radio telescope, known as the *Big Ear*, and Grote Reber was at Ohio State to receive an honorary doctorate. In this photo, taken at the *Big Ear* construction site, are [left to right]: T. Kochu Menon, Reber, Kraus, and Robert T. Nash. Woodruff T. Sullivan III interviewed Menon, Reber, and Kraus for his history of radio astronomy (see article above). Photo from the Papers of John D. Kraus in the NRAO Archives.

From the Archives is an ongoing series illustrating NRAO and U.S. radio astronomy history via images selected from our collections of individuals' and institutional papers. If readers have images they believe would be of interest to the Archives, please contact Ellen Bouton, **ebouton@nrao.edu (mailto:ebouton@nrao.edu)** .

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